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Ecological Risk Assessment for Effects of Fishing

Report for the Southern Bluefin Tuna Fishery: Purse Seine Sub-Fishery 2015-2019

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Report for the Australian Fisheries Management Authority

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Executive summary

This assessment of the ecological impacts of the Southern Bluefin Tuna Purse Seine sub-fishery was undertaken using the ERAEF method version 9.2. ERAEF stands for "Ecological Risk Assessment for Effect of Fishing" and was developed jointly by CSIRO Marine and Atmospheric Research, and the Australian Fisheries Management Authority. ERAEF provides a hierarchical framework for a comprehensive assessment of the ecological risks arising from fishing, with impacts assessed against five ecological components – key commercial species; by-product and by-catch species; protected species; habitats; and (ecological) communities.

ERAEF proceeds through four stages of analysis: scoping; an expert judgement-based Level 1 analysis (SICA – Scale Intensity Consequence Analysis); an empirically based Level 2 analysis (PSA – Productivity Susceptibility Analysis); and a model-based Level 3 analysis. This hierarchical approach provides a cost-efficient way of screening hazards, with increasing time and attention paid only to those hazards that are not eliminated at lower levels in the analysis. Risk management responses may be identified at any level in the analysis.

Application of the ERAEF methods to a fishery can be thought of as a set of screening or prioritization steps that work towards a full quantitative ecological risk assessment. At the start of the process, all components are assumed to be at high risk. Each step, or Level, potentially screens out issues that are of low concern. The Scoping stage screens out activities that do not occur in the fishery. Level 1 screens out activities that are judged to have low impact, and potentially screens out whole ecological components as well. Level 2 is a screening or prioritization process for individual species, habitats and communities at risk from direct impacts of fishing. The Level 2 methods do not provide absolute measures of risk. Instead they combine information on productivity and exposure to fishing to assess potential risk – the term used at Level 2 is risk. Because of the precautionary approach to uncertainty, there will be more false positives than false negatives at Level 2, and the list of high-risk species or habitats should not be interpreted as all being at high risk from fishing. Level 2 is a screening process to identify species or habitats that require further investigation. Some of these may require only a little further investigation to identify them as a false positive; for some of them managers and industry may decide to implement a management response; others will require further analysis using Level 3 methods, which do assess absolute levels of risk.

This assessment of the SBT Purse Seine sub-fishery includes the following:

- Scoping
- Level 1 results for all components

Fishery Description and comparison with previous assessment period

Gear: Purse seine and towed cage

Area: Great Australian Bight – specifically area west and south east of Kangaroo Island. Targeting juvenile Southern Bluefin Tuna (2–5 years) in the catch is transferred to aquaculture farming operations off the coast of Port Lincoln in South Australia.

Depth range: 50 m - deep

Fleet size: 6-7 purse seiners plus towing and feeding vessels.

Effort: 112-198 shots/906 -1366 search hours annually

Landings: 4683-5291 t SBT annually

Discards: 655 t SBT total 2015 – 2018 (all discards of SBT in this fishery are live releases)

Key commercial species: Southern Bluefin Tuna (SBT)

Management: Quota management for SBT, total catch divided equally to vessel according to their statutory fishing rights (SFR). Bait species also assessed under quota from SPF.

Input controls: SFRs control the catch and the amount and type of gear

Output controls: Total Allowable Catch for SBT per fishing year. No limits on bait collection.

Observer program: 9-21 % coverage annually (2013-2018)

Table ES.1. Current stock status, assessment and tier status, for commercial and bycatch species SBT purse seine sub-fishery. Primary target C1; Commercial bait CB. na not applicable. ^ *Fishery Status Reports 2020;* NSTOF Not subject to overfishing; NOF Not overfished; OF Overfished; F fishing mortality; B biomass. ^^ *Status of Key Australian Fish Stocks 2018*. DEPM Daily Egg Production Method.

ROLE IN FISHERY	COMMON NAME (SPECIES)	TIER	STOCK STATUS^	STOCK STATUS^^	STOCK ASSESSMENT	LAST YEAR ASSESSED	COMMENTS
C1	Southern Bluefin Tuna *Thunnus maccoyii*	Not applicable	NSTOF (F) OF (B) Patterson *et al.* 2020	Recovering Patterson & Nicol (2018)	CCSBT 2020	2020	20% of TRO[1]
CB	Redbait west *Emmelichthys nitidus*	1	NSTOF (F) NOF (B) Noriega and Steven 2020	-	Ward and Grammer 2020	2017	Spawning biomass DEPM, exploitation rate, catch
CB	Australian Sardine *Sardinops sagax*	1	NSTOF (F) NOF (B) Noriega and Steven 2020	Sustainable Ward *et al.* (2018b)	Ward *et al.* 2020, Ward and Grammer 2020	2018	Spawning biomass DEPM, exploitation rate, catch
CB	Jack Mackerel west *Trachurus declivis*	1	NSTOF (F) NOF (B) Noriega and Steven 2020	Sustainable Ward *et al.* 2018a	Ward and Grammer 2018, 2020	2018 (using data form 2016)	Spawning biomass DEPM, exploitation rate, catch

ROLE IN FISHERY	COMMON NAME (SPECIES)	TIER	STOCK STATUS^	STOCK STATUS^^	STOCK ASSESSMENT	LAST YEAR ASSESSED	COMMENTS
CB	Blue Mackerel west *Scomber australasicus*	3	NSTOF (F) NOF (B) Noriega and Steven 2020	Sustainable Ward et al (2018c)	Ward and Grammer 2018, 2020	2018 (using data form 2016)	Spawning biomass DEPM (2005), exploitation rate, catch
BC	Skipjack Tuna *Katsuwonus pelamis*	Not applicable	NSTOF (F) NOF (B) Patterson and Mobsby 2020	-	West -IOTC 2017 East- Vincent, Pilling and Hampton 2019	West - 2017 East - 2019	2 stocks: western stock part of larger Indian Ocean population - most relevant; eastern stock part of the broader stock in Pacific Ocean.

[1] TRO Total reproductive output - which is now used to assess reproductive capacity rather than SSB.

Table ES.2 Comparison of ecological units assessed in 2007 and 2020 SICA analyses

COMPONENT	2007 (PREVIOUS)	2020 (CURRENT)
Key/secondary commercial species	1 primary, 10 bait	1 key, 10 bait
By-product/ bycatch species	14	25
Protected species	182	14
Habitats	209 benthic, 2 pelagic	4* benthic, 2 pelagic
Communities	2 demersal, 2 pelagic	3 demersal, 2 pelagic

* based on Pitcher *et al.* 2018 and are not comparable with current assessment

A total of 50 species across the three ecological components were assessed in this ERAEF compared to 207 species assessed in 2007 (Table ES.2). The reduction in the number of protected species between assessments is due to the inclusion of only species that interacted, or have recently interacted, in this sub-fishery during the assessment period (apart from any expansion of species groups identified from AFMA logbook and/or Observer data).

Level 1 Results

All ecological components were eliminated at Level 1 i.e. there were no risk scores of 3 – moderate – or above for any internal component (Table ES.3).

All hazards (fishing activities) were eliminated at Level 1 (risk scores 1 or 2).

Significant external hazards were found for key commercial and protected species, and communities from other fisheries, and for protected species and communities from aquaculture.

Table ES.3 Comparison of previous and current assessments

ECOLOGICAL COMPONENT	2007 (PREVIOUS)	2020 (CURRENT)
Key/secondary commercial species	L2	L1
Byproduct and bycatch	L1	L1
Protected species	L2	L1
Habitats	L1	L1
Communities	L2 – not assessed	L1

Summary

No high risks were identified for any components assessed in the SBT purse seine sub-fishery from internal activities. The external activities that impacted components were other fisheries on key commercial and protected species, and communities, and aquaculture on protected species and communities.

There is only one key commercial species, Southern Bluefin tuna (SBT) *Thunnus maccoyii*, permitted to be captured in this fishery unless statutory rights for other captured species are held. The CCSBT assessment of SBT determines a global TAC that allows the rebuilding of the stock, which has been about 5% pa since a minimum in 2009. SBT is currently estimated to be at 20% (16-24% 80%PI) of unfished levels but remains below a level required to produce an MSY (CCSBT 2020). In this ERA, the higher-level stock assessment of SBT obviated the need for assessment of direct capture by fishing but other activities were still assessed. Only external fisheries were found to be of moderate or high risk to SBT. The current fishing mortality rate is below the level that would produce an MSY (CCSBT 2020) but it was noted by Patterson *et al.* (2020a) that accounting for all mortality sources i.e. from recreational and indigenous catch, improving the confidence in estimates of purse seine catches, and supporting stock recovery were necessary to maintain Australia's export trade approval, an important consideration for SBT fishery management. Five percent of Australia's allocation from CCSBT is set aside annually to account for mortality from recreational fishing. SBT is now classified as not subject to overfishing, although the stock biomass is still overfished.

Live bait is caught with smaller nets for the purposes of attracting tuna. Unlimited amounts of live bait species (*Emmelichthys nitidus*, *Trachurus* spp., *Sardinops sagax*, *Clupea* spp., *Scomber australasicus* and *Engraulis australis*) are permitted but since using frozen sardine sourced from the South Australian Sardine Fishery (SASF) is now the preferred practice, the practice of catching live bait is decreasing. Currently, catches of bait are not recorded but are reported to be less 5 tonnes per year (M. Daniel 16/10/20 pers. comm.). Several of the bait species i.e. Redbait *Emmelichthys nitidus*, Jack Mackerel *Trachurus declivis*, Australian Sardine *Sardinops sagax* and Blue Mackerel *Scomber australasicus* are assessed within the Small Pelagic Fishery or the SASF therefore we did not consider impact of direct capture on the populations themselves, only on other species. Overall, all internal activities were assessed as low risk and only the combined other fisheries, an external activity, was assessed as a moderate risk.

The targeted nature of the Purse Seine fishery, the depth at which it is conducted, and the fact that live fish are transferred to cages to be towed slowly inshore to grow-out facilities, minimizes the risk of capture of non-target species, and for those that might be captured, all efforts are made to release them. No bycatch species were recorded as being landed or discarded in the fisher's logbooks, but the observers recorded some discarding including large quantities of jellyfish, and some sponges. Other species recorded by the observers since 2015 were usually single occurrences or less than 20 kg. The only species discarded of any commercial importance was Skipjack Tuna *Katsuwonus pelamis*. The Indian Ocean Tuna Commission's assessment of Skipjack Tuna estimates the stock to be above the target reference point of 40% of unfished spawning biomass (IOTC 2017) and there has been no effort in the Australian Skipjack fishery since 2008/9 (Patterson & Mobsby 2020). The existence of a current stock assessment meant we did not assess Skipjack for direct capture despite uncertainty about the inclusion of discard mortality from a variety of fisheries in those assessments. Furthermore, we found no activities that presented more than a minor risk to Skipjack Tuna. However, we did assess other activities' impacts on Skipjack Tuna when appropriate. There were no activities either internal or external that were assessed as moderate or higher risk. Bronze Whaler Carcharhinus brachyurus was assessed as the most vulnerable species subject to capture by fishing because it is often caught and released and has no estimates of population abundance/status.

Historically, physical interactions with protected species are rare and during this assessment period none were caught or injured. However, a few species are influenced by the operations, particularly chumming. According to observer reports, Short-tailed and Flesh-footed Shearwaters *Puffinus tenuirostris* and *Puffinus carneipes,* are commonly seen feeding on the bait often to the extent that the tuna cannot access the baits. Flesh-footed Shearwaters were the most abundant bird observed during the current assessment period. The previous assessment period reported two White Sharks *Carcharhinus obscurus* caught and subsequently released but there were no records in the observer reports or logs. The pre-2015 Wildlife logbooks recorded a seal and a Shortfin Mako *Isurus oxyrinchus,* both released. Observers have reported

that divers find holes torn by sharks in nets. In view of these interactions we included all these species in the assessment even though there were no physical or fatal interactions. Consequently, no activities were assessed as a moderate or higher risk to protected species. However, the external activities, other fisheries and aquaculture, resulted in moderate to severe consequences respectively.

The Habitats component presented a conundrum. The purse seine method is a pelagic method that normally does not impact benthic habitats, but the observer logs recorded the capture of benthos, as much of 400 kg sponges, and a few instances of demersal fauna such as sand crabs, stony corals and demersal fishes. While the quantities of these are relatively trivial over the 5-year assessment period even after accounting for the at most ~20% observer coverage, it raises the question of how often seines touch the bottom, how lightly, and the recovery rate of the vulnerable benthos. However, there is little research about the impact of more frequent "grazes" particularly in vulnerable habitats and this assessment did not identify any vulnerable habitats at risk within the footprint of the fishery. Furthermore, impact from demersal trawling, a relatively destructive method compared to Purse Seine, was among the lowest of all Australian shelf regions (Pitcher at al. 2018), therefore the consequence was considered minor.

Communities were assessed at moderate risk from external fisheries from the additional fishing pressure on SBT and from aquaculture by way of removing small pelagic species to feed the tuna in the grow-out pens. The stock status of SBT is assessed by the CCSBT which manages the allocations to in order to rebuild stocks; AFMA manages the quota allocated to Australia. The community composition of this large predator functional group has been impacted since the 1960s when global catches peaked at 80,000 t (Patterson *et al.* 2020a). Australian catches have remained stable since 1990 and impact of the Purse Seine fishery on the current species composition is unlikely to be causing a major change to the present overall system function. Potentially, the removal of small pelagic species from the South Australian Sardine Fishery (SASF) to maintain the grow-out of farmed tuna might have also have detectable changes, particularly at a localised scale but without a major change in ecosystem function. Therefore, while the fishery itself did not pose significant consequences to communities, external fisheries and aquaculture did.

Managing identified risks

Using the results of the ecological risk assessment, we did not identify any risks from internal activity scenarios of the SBT Purse Seine sub-fishery.

1 Overview

1.1 Ecological Risk Assessment for the Effects of Fishing (ERAEF) Framework

1.1.1 The Hierarchical Approach

The Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework involves a hierarchical approach that moves from a comprehensive but largely qualitative analysis of risk at Level 1, through a more focused and semi-quantitative approach at Level 2, to a highly focused and fully quantitative "model-based" approach at Level 3 (Figure 1.1). This approach is efficient because many potential risks are screened out at Level 1, so that the more intensive and quantitative analyses at Level 2 (and ultimately at Level 3) are limited to a subset of the higher risk activities associated with fishing. It also leads to rapid identification of high-risk activities, which in turn can lead to immediate remedial action (risk management response). The ERAEF approach is also precautionary, in the sense that risks will be scored high in the absence of information, evidence or logical argument to the contrary.

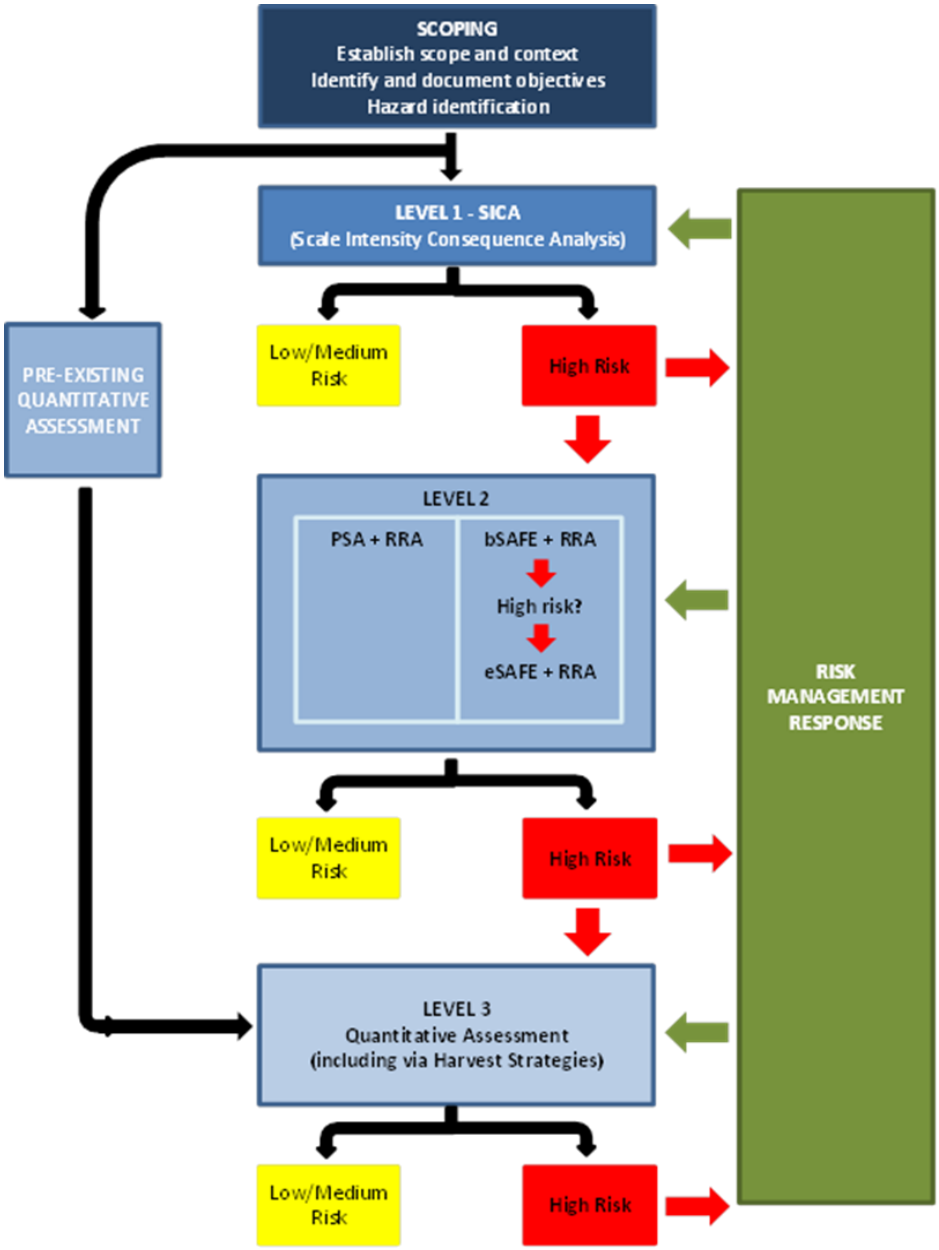


Figure 1.1. Structure of the 3-level hierarchical ERAEF methodology. SICA – Scale Intensity Consequence Analysis; PSA – Productivity Susceptibility Analysis; SAFE – Sustainability Assessment for Fishing Effects; RRA – Residual Risk Analysis. T1 – Tier 1. eSAFE may be used for species classified as high risk by bSAFE.

Conceptual Model

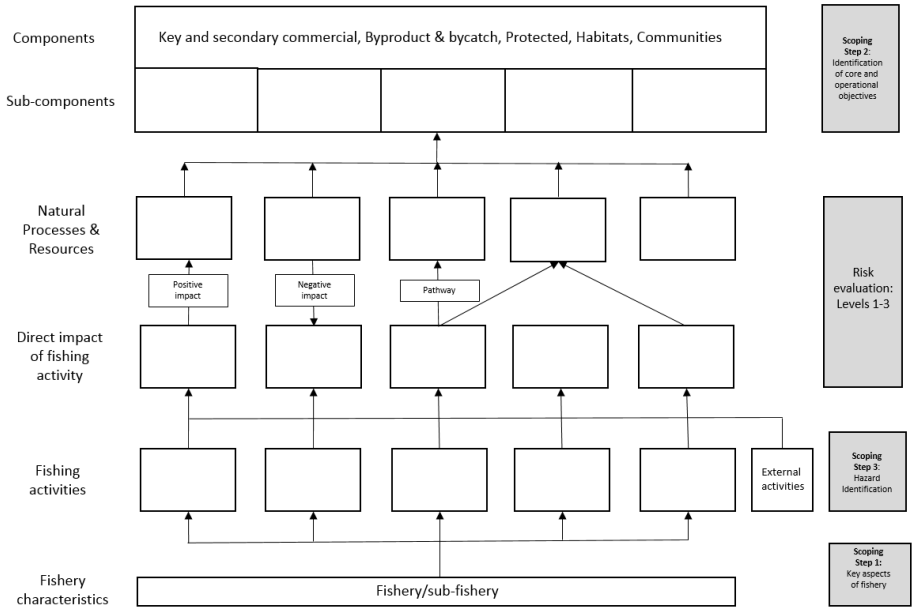
The approach makes use of a general conceptual model of how fishing impacts on ecological systems, which is used as the basis for the risk assessment evaluations at each level of analysis (Levels 1-3). For the ERAEF approach, five general ecological components are evaluated, corresponding to five areas of focus in evaluating impacts of fishing for strategic assessment under EPBC legislation. The five revised *components* are:

- Key commercial species and secondary commercial species

- Byproduct and bycatch species
- Protected[1] species (formerly referred to as threatened, endangered and protected[2] species or TEPS)
- Habitats
- Ecological communities

This conceptual model (

Figure 1.2) progresses from *fishery characteristics* of the fishery or sub-fishery, → *fishing activities* associated with fishing and *external activities*, which may impact the five ecological components (key commercial, byproduct and bycatch species, protected species, habitats, and communities); → *effects of fishing and external activities* which are the direct impacts of fishing and external activities; → *natural processes and resources* that are affected by the impacts of fishing and external activities; → *sub-components* which are affected by impacts to natural processes and resources; → *components*, which are affected by impacts to the sub-components. Impacts to the sub-components and components in turn affect achievement of management objectives.



[1] The ct (1999) and r monly used

[2] Not 99) while "Prot ulnerable, endangered or critically endangered).

Figure 1.2. Generic conceptual model used in ERAEF.

The external activities that may impact the fishery objectives are also identified at the Scoping stage and evaluated at Level 1. This provides information on the additional impacts on the ecological components being evaluated, even though management of the external activities is outside the scope of management for that fishery.

The assessment of risk at each level takes into account current management strategies and arrangements. A crucial process in the risk assessment framework is to document the rationale behind assessments and decisions at each step in the analysis. The decision to proceed to subsequent levels depends on

- Estimated risk at the previous level
- Availability of data to proceed to the next level
- Management response (e.g. if the risk is high but immediate changes to management regulations or fishing practices will reduce the risk, then analysis at the next level may be unnecessary).

1.1.2 ERAEF stakeholder engagement process

A recognized part of conventional risk assessment is the involvement of stakeholders involved in the activities being assessed. Stakeholders can make an important contribution by providing expert judgment, fishery-specific and ecological knowledge, and process and outcome ownership. The ERAEF method also relies on stakeholder involvement at each stage in the process, as outlined below. Stakeholder interactions are recorded.

1.1.3 Scoping

In the first instance, scoping is based on review of existing documents and information, with much of it collected and completed to a draft stage prior to full stakeholder involvement. This provides all the stakeholders with information on the relevant background issues. Three key outputs are required from the scoping, each requiring stakeholder input.

1. Identification of units of analysis (species, habitats and communities) potentially impacted by fishery activities (Section 2.2.2; Scoping Documents S2A, S2B1, S2B2 and S2C1, S2C2).

2. Selection of objectives (Section 2.2.3; Scoping Document S3). The primary objective to be pursued for species assessed under ERAF is that of ensuring populations are maintained at biomass levels above which recruitment failure is likely, as stated in Chapter 2 (AFMA (2016), ERM Guide). This is consistent with current legislation and fisheries policies and represents a change from when the ERAEF was first developed and there was less policy or legislation based guidance on sustainability objectives, with stakeholders able to choose from a range of "sustainability" objectives (e.g.: tables 5A-C in Hobday *et al.* 2007b).
3. Selection of activities (hazards) (Section 2.2.4; Scoping Document S4) that occur in the sub-fishery is made using a checklist of potential activities provided. The checklist was developed following extensive review and allows repeatability between fisheries. Additional activities raised by the stakeholders can be included in this checklist (and would feed back into the original checklist). The background information and consultation with the stakeholders is used to finalize the set of activities. Many activities will be self-evident (e.g. fishing, which obviously occurs), but for others, expert or anecdotal evidence may be required.

1.1.4 Level 1. SICA (Scale, Intensity, Consequence Analysis)

The SICA analysis evaluates the risk to ecological components resulting from the stakeholder-agreed set of activities. Evaluation of the temporal and spatial scale, intensity, sub-component, unit of analysis, and credible scenario (consequence for a sub-component) should be prepared by the draft fishery ERAF report author and reviewed at an appropriate stakeholder meeting (e.g. Resource Assessment Group meeting). Due to the number of activities (up to 24) in each of five components (resulting in up to 120 SICA elements), preparation before involving the full set of stakeholders may allow time and attention to be focused on the uncertain or controversial or high risk elements. Documenting the rationale for each SICA element ahead of time for the straw-man scenarios is crucial to allow the workshop debate to focus on the right portions of the logical progression that resulted in the consequence score.

SICA elements are scored on a scale of 1 to 6 (negligible to extreme) using a "plausible worst case" approach (see ERAEF Methods Document for details; Smith *et al.* 2007). Level 1 analysis potentially result in the elimination of activities (hazards) and in some cases whole components. Any SICA element that scores 2 or less is documented, but not considered further for analysis or management response.

1.1.5 Level 2. PSA and SAFE (semi-quantitative and quantitative methods)

When the risk of an activity at Level 1 (SICA) on a species component is moderate or higher and no planned management interventions that would remove this risk are identified, an assessment is required at Level 2 (to determine if the risk is real and provide further information on the risk). The tools used to assess risk at Level 2 allow units (e.g. all individual species) within any of the ecological species components (e.g. key/secondary commercial, byproduct/bycatch, and protected species) to be effectively and comprehensively screened for risk. The analysis units are identified at the scoping stage. To date, Level 2 tools have been

designed to measure risk from direct impacts of fishing only (i.e. risk of overfishing, leading to an overfished fishery), which in all assessments to date has been the hazard with the greatest risks identified at Level 1[3].

In the period since the first ERAEF was implemented across Commonwealth fisheries, much of the management focus has been on the assessment results associated with Level 2 and Level 2.5 or 3 risk assessment methods, which comprise semi-quantitative or rapid simple quantitative methods (e.g. PSA and SAFE). This level has been subject to the greatest level of change and improvement which are discussed in the following sections. Additional improvements are being developed for implementation in the near future (see Chapter 4.13 of AFMA ERM Guide, AFMA (2016)).

Level 2 was originally designed to rely on a single risk assessment methodology, the Productivity-Susceptibility Analysis (PSA) (see Chapter 4.8.3 of AFMA ERM Guide, AFMA (2016)), however a more quantitative method called the Sustainability Assessment for Fishing Effects (SAFE) (see Chapter 4.8.4 of AFMA ERM Guide, AFMA (2016)) was developed early in the implementation of the ERAEF and classed as a Level 2.5 or Level 3 tool.

Under the revised ERAEF:

bSAFE has now been reclassified as the preferred Level 2 method (over PSA) where sufficient spatial and biological data (to support bSAFE) are available. Typically, this has been used for teleost and 6 chondrichthyan species.

Species estimated to be at high risk under bSAFE may then be assessed under eSAFE which may provide reduced estimates of uncertainty pertaining to the actual risk.

Where either the data or species biological characteristics are insufficient to support bSAFE analyses, it is recommended that PSA be applied instead. This will be the case for many protected species, invertebrate bycatch species and some other species.

At Level 2, either PSA or SAFE methods should be applied to any given species, not both.

For high risk species it is a management choice whether to progress to eSAFE, pursue a Level 3 fully quantitative stock assessment, or to take more immediate management action to reduce the risk. The types of considerations required in making that choice (i.e.: moving up the ERAEF assessment hierarchy or taking direct management action) are outlined in Chapter 5.5 of the AFMA ERM Guide (AFMA (2016).

It is also recognised that several additional tools, including some of the “data poor” assessment tools that are used to inform harvest strategies, could potentially be included within the Level 2 toolkit. They are distinguished from Level 3 quantitative tools (i.e. stock assessment models) that are more data rich and able to more precisely quantify uncertainty.

PSA (Productivity Susceptibility Analysis))

Details of the PSA method are described in the accompanying ERAEF Methods Document and summarised in Section 4.8.3 of the AFMA ERM Guide (AFMA 2016). Stakeholders can provide input and suggestions on appropriate attributes, including novel ones, for evaluating risk in the specific fishery. Attribute values for many of the units (e.g. age at maturity, depth range, mean trophic level) can be obtained from published literature and other resources (e.g. scientific

[3] Future iterations of the methodology will include PSAs modified to measure the risk due to other activities, such as gear loss.

experts) without initial stakeholder involvement. Stakeholder input is required after preliminary attribute values are obtained. In particular, where information is missing, expert opinion can be used to derive the most "reasonable" conservative estimate. For example, if species attribute values for annual fecundity have been categorized as low, medium or high on the set (<5, 5-500, >500), estimates for species with no data can still be made. Also, estimated fecundity of a broadcast-spawning fish species with unknown fecundity is still likely to be greater than the high fecundity category (>500). Susceptibility attribute estimates, such as "fraction alive when landed", can also be made based on input from experts such as scientific observers. Feedback to stakeholders regarding comments received during the preliminary PSA consultations is considered crucial. The final PSA is completed by scientists and results are presented to the relevant stakeholder group (e.g. RAG and/or MAC) before decisions regarding Level 3 analysis are considered. The stakeholder group may also decide on priorities for analysis at Level 3.

Residual Risk Analysis

There were several limitations due to the semi-quantitative nature of a Level 2 PSA assessment. For example, certain management arrangements which mitigate the risks posed by a fishery, as well as additional information concerning levels of direct mortality, may not be easily taken into account in assessments. To overcome this, Residual risk analyses (RRA) are used to consider additional information, particularly mitigating effects of management arrangements that were not explicitly included in the ERAs or introduced after the ERA process commenced. Priority for this process has typically been focused on those species attributed a high-risk rating (those likely to be most at risk from fishing activities). It could in theory be used to also determine if some species have been incorrectly classified as low risk.

Recently revised Residual risk guidelines have been developed (see below) to assist in making accurate judgments of residual risk consistently across all fisheries. At the moment, they are applied to species and not applicable to habitats or communities.

These guidelines are not seen as a definitive guide on the determination of residual risk and it is expected they may not apply in a small number of cases. Care must also be taken when applying them to ensure residual risk results are appropriate in a practical sense. There are a number of conditions which underpin the residual risk guidelines and should be understood before the guidelines are applied:

- All assessments and management measures used within the residual risk assessment must be implemented prior to the assessment with sufficient data to demonstrate the effect. Any planned or proposed measures can be referred to in the assessment but cannot be used to revise the risk score.
- When applied, the guidelines generally result in changes to particular "attribute" scores for a particular species. Only after all of the guidelines have been applied to a particular species, should the overall risk category be re-calculated. This will ensure consistency, as well as facilitating the application of multiple guidelines.
- Unless there is clear and substantiated information to support applying an individual guideline, then the attribute and residual risk score should remain unchanged. All supporting information considered in applying these Guidelines must be clearly documented and referenced where applicable. This is consistent with the precautionary approach applied in ERAs, with residual risk remaining high unless there is evidence to the contrary ensuring a transparent process is applied.

The results (including supporting information and justifications) from residual risk analyses must be documented in "Residual Risk Reports" for each fishery (or can be integrated into the Level 2 risk assessment report). These will be publicly available documents.

SAFE (Sustainability Assessment for Fishing Effects)

The SAFE method developed is split into two categories: base SAFE (bSAFE) and an enhanced SAFE (eSAFE). eSAFE has greater data processing requirements and is recommended to only be used to assess species estimated to be at high risk via the bSAFE. It is also able to more appropriately model spatial availability aspects when sufficient data are available.

bSAFE

Relative to the PSA approach, the bSAFE approach (Zhou and Griffiths, 2008; Zhou *et al.* 2011):

- is a more quantitative approach (analogous to stock assessment) that is able to provide absolute measures of risk by estimating fishing mortality rates relative to fishing mortality rate reference points (based on life history parameters);
- requires less productivity data than the PSA;
- can account for cumulative risk and
- potentially out-performs PSA in several areas, including strength of relationship to Tier 1 assessment classifications (Zhou *et al.* 2016).

Like PSA, the bSAFE method is a transparent, relatively rapid and cost-effective process for screening large numbers of species for risk and is far less demanding of data and much simpler to apply than a typical quantitative stock assessment.

As such it is recommended that bSAFE be used as the preferred Level 2 assessment tool for all fish species and some invertebrates and reptiles (e.g.: some sea snakes) with sufficient data.

In estimating fishing mortality, bSAFE utilises much of the same information as the PSA, to estimate:

- spatial overlap between species distribution and fishing effort distribution.
- catchability resulting from the probability of encountering the gear and size-dependent selectivity, and;
- post-capture mortality.

The fishing mortality is essentially the fraction of overlap between fished area and the species distribution area within the jurisdiction, adjusted by catchability and post-capture mortality. Uncertainty around the estimated fishing mortality is estimated by including variances in encounterability, selectivity, survival rate and fishing effort between years.

The three biological reference points are based on a simple surplus production model:

- $\mathbf{F_{MSY}}$ – instantaneous fishing mortality rate that corresponds to the maximum number of fish in the population that can be killed by fishing in the long term. The latter is the maximum sustainable fishing mortality (MSM) at B_{MSM}, similar to target species MSY.
- $\mathbf{F_{LIM}}$ – instantaneous fishing mortality rate that corresponds to the limit biomass B_{LIM} where B_{LIM} is a assumed to be half of the biomass that supports a maximum sustainable fishing mortality ($0.5B_{MSM}$).
- $\mathbf{F_{CRASH}}$ – minimum unsustainable instantaneous fishing mortality rate that, in theory, will lead to population extinction in the long term.

This methodology produces quantified indicators of performance against fishing mortality-based reference points and as such does allow calibration with other stock assessment and risk assessment tools that measure fishing mortality. It allows the risk of overfishing to be determined, via the score relative to the reference line. Uncertainty (error bars) are related to the variation in the estimation of the scores for each axis.

It is recommended that species assessed as being potentially at high risk under bSAFE are then progressed to analysis by eSAFE which can narrow uncertainties around the risk (but is more time and resource intensive than bSAFE).

Assumptions and issues to be aware of are:

- comparisons of PSA and SAFE analyses for the same fisheries and species support the claim that the PSA method generally avoids false negatives but can result in many false positives. Limited testing of SAFE results against full quantitative stock assessments suggest that there is less “bias” in the method, but that both false negatives and false positives can arise
- SAFE analyses retain some of the key precautionary elements of the PSA method, including assumptions that fisheries are impacting local stocks (within the jurisdictional area of the fishery)
- although the bSAFE analyses provide direct estimates of uncertainty in both the exploitation rate and associated reference points, they are less explicit about uncertainties arising from key assumptions in the method, including spatial distribution and movement of stocks.
- The method assumes there would be no local depletion effects from repeat trawls at the same location (i.e.: populations rapidly mix between fished and unfished areas). The fishing mortality will likely be overestimated if this assumption is not satisfied (ERA TWG 2015).
- The method also assumes that the mean fish density does not vary between fished area and non-fished area within their distributional range. Hence, the level of risk would be over-estimated for species found primarily in non-fished habitat, while risk would be under-estimated for species that prefer fished habitat (ERA TWG 2015).

The SAFE methodology makes greater assumptions than Tier 1 stock assessments in coming to its F estimates (due to a lack of the data relative to that used in a Tier 1 assessment) and it is not capable of measuring risk of a stock being already overfished (so the type of risk it measures relates only to overfishing, which may then lead to future overfished state). The limitations of SAFE with respect to measuring overfished risks are the same essentially as for PSA.

eSAFE

Enhanced SAFE (eSAFE) appears, based on calibration with Level 3 assessments, to provide improved estimates of fishing mortality relative to the base SAFE (bSAFE) method. The eSAFE requires more spatially explicit data and takes more analysis time than bSAFE, and so might only be used to further assess species that were identified as at high risk using bSAFE (and which have not had further direct management action taken). The eSAFE enhances the bSAFE method by estimating varying fish density across their distribution range as well as species- and gear-specific catch efficiency for each species.

1.1.6 Level 3

This stage of the risk assessment is fully quantitative and relies on in-depth scientific studies on the units identified as at medium or greater risk in the Level 2. It will be both time and data intensive. Individual stakeholders are engaged as required in a more intensive and directed fashion. Results are presented to the stakeholder group and feedback incorporated, but live modification is not considered likely.

1.1.7 Conclusion and final risk assessment report

The conclusion of the stakeholder consultation process will result in a final risk assessment report for the individual fishery according to the ERAEF methods. It is envisaged that the completed assessment will be adopted by the fishery management group and used by AFMA for a range of management purposes, including to address the requirements of the EPBC Act as evaluated by Department of the Environment and Heritage.

1.1.8 Subsequent risk assessment iterations for a fishery

The frequency at which each fishery must revise and update the risk assessment is not fully prescribed. As new information arises or management changes occur, the risks can be re-evaluated, and documented as before. The fishery management group or AFMA may take ownership of this process, or scientific consultants may be engaged. In any case the ERAEF should again be based on the input of the full set of stakeholders and reviewed by independent experts familiar with the process.

Fishery re-assessments for byproduct and bycatch species under the ERAEF will be undertaken every five years[4] or sooner if triggered by re-assessment triggers. The five-year timeframe is based on a number of factors including:

The time it takes to implement risk management measures; for populations to respond to those measures to a degree detectable by monitoring processes; and to collect sufficient data to determine the effectiveness of those measures.

- Alignment with other management and accreditation processes.
- The cost of re-assessments.
- The review period for FMS.

For byproduct and bycatch species, in the periods between scheduled 5 year ERA reviews[5], AFMA will develop and monitor a set of fishery indicators and triggers, on an annual basis, so as to detect any changes (increase or decrease) in the level of risk posed by the fishery to any

[4] Based on a recommendation by the ERA Technical Working Group, September 2015.

[5] In contrast to key and secondary commercial species managed via catch/effort limits under Harvest Strategies, which depending on species and Harvest Strategy, can be re-assessed any time between 1 and 5 years.

species. Where indicators exceed specified trigger levels, AFMA will investigate the causes and provide opportunity for RAG comment/advice during that process. Pending outcomes of that review, and RAG advice, AFMA can if necessary, request a species specific or full fishery re-assessment (i.e. prior to the scheduled re-assessment dates).

The ERA TWG (September 2015) identified five key indicators upon which such triggers could be based, these being changes in:

- Gear type/use
- Mitigation measures (use or type)
- Area fished
- Catch or interaction rate
- Fishing effort

Where possible, the triggers should look to take into account additional sources of risk from interacting non-Commonwealth fisheries. In addition, if a major management change is planned for a fishery, such as a move from input to output controls, the fishery will need to be reassessed prior to that management change coming into effect. In considering each indicator and trigger level, the RAG should consider the following:

- The data upon which the indicator is based must be sufficiently representative of actual changes in catch, effort, area, gear or mitigation methods. Consideration should be given to the level of uncertainty associated with the data underpinning any prospective indicator.
- The trigger level chosen should not be overly sensitive to the normal inter-annual variance that is typical of the indicator and independent of fishing pressure, assuming such variance is unlikely to relate to a significant change in the risk posed by the fishery to any or all species.
- The trigger level should equate to the minimum level of change that the RAG (by its expert opinion) considers might potentially represent a significant change in the risk posed by the fishery.
- The trigger level could represent an absolute change (number/level) in an indicator or a percentage change in an indicator.
- The RAG should consider whether a “temporal” condition should be placed on the trigger (i.e. the trigger is breached 2 years in a row) to further reduce the likelihood of natural population variance or data errors triggering a re-assessment unnecessarily.

The final set of indicators and triggers will be developed for each fishery by AFMA in consultation with its fishery RAG (or for fisheries lacking a RAG, the ERA TWG), in association with the next planned re-assessment (see Table 8 in AFMA ERM Guide, AFMA (2016)). A RAG may choose a subset of these indicators and triggers or include an additional indicator/trigger(s), based on consideration of the availability and reliability of data upon which to base any of the above indicators/triggers, however justification of this must be provided.

Research is currently underway to develop specific guidance for RAG to aid in the selection of appropriate triggers, which will in the meantime be determined using RAG expert opinion. In the longer term it may be possible to refine indicators and triggers using the existing PSA and SAFE methods to test which attributes the end risk scores are most sensitive to (ERA TWG

2015)[6]. The RAG will record both the final set of indicators and triggers chosen, and a justification for those, in the RAG minutes. Once the final set of indicators and triggers is determined for a fishery, they will require implementation within the FMS and a monitoring and review process.

[6] ERA TWG recommendation, September 2015

2 Results

The focus of analysis is the fishery as identified by the responsible management authority. The assessment area is defined by the fishery management jurisdiction within the AFZ. The fishery may also be divided into sub-fisheries based on fishing method and/or spatial coverage. These sub-fisheries should be clearly identified and described during the scoping stage. Portions of the scoping and analysis at Level 1 and beyond, is specific to a sub-fishery. The fishery is a group of people carrying out certain activities as defined under a management plan. Depending on the jurisdiction, the fishery/sub-fishery may include any combination of commercial, recreational, and/or indigenous fishers.

The results presented below are for the Southern Bluefin Tuna purse seine fishery.

2.1 Stakeholder engagement

Table 2.1 Summary Document SD1. Summary of stakeholder involvement for Southern Bluefin Tuna purse seine sub-fishery.

FISHERY ERA REPORT STAGE	TYPE OF STAKEHOLDER INTERACTION	DATE OF STAKEHOLDER INTERACTION	COMPOSITION OF STAKEHOLDER GROUP (NAMES OR ROLES)	SUMMARY OF OUTCOME
Scoping & SICA	Emails, phone calls	Sept-Nov 2020	Matthew Daniels, AFMA SBT Manager	Data summaries, clarification of specific fisheries arrangements
Draft ERA report		November 2020	Submitted draft report	

2.2 Scoping

The aim in the Scoping stage is to develop a profile of the fishery being assessed. This provides information needed to complete Levels 1 and 2 and at stakeholder meetings. The focus of analysis is the fishery, which may be divided into sub-fisheries based on fishing method and/or spatial coverage. Scoping involves six steps:

- Step 1 Documenting the general fishery characteristics
- Step 2 Generating "unit of analysis" lists (species, habitat types, communities)
- Step 3 Selection of objectives
- Step 4 Hazard identification
- Step 5 Bibliography
- Step 6 Decision rules to move to Level 1

2.2.1 General Fishery Characteristics (Step 1).

The information used to complete this step may come from the Fishery Management Plan, Assessment Reports, Bycatch Action Plans, and any other relevant background documents. The level and range of information available will vary. Some fisheries/sub-fisheries will have a range of reliable information, whereas others may have limited information.

Scoping Document S1 General Fishery Characteristics

Fishery Name: Southern Bluefin Tuna - Purse Seine

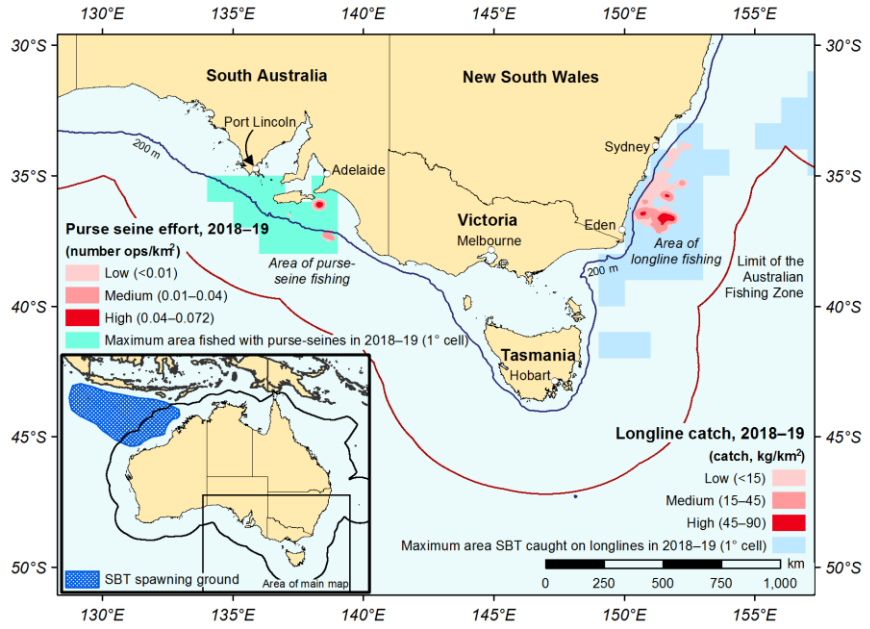
Date of assessment: December 2020

Assessor: AFMA and authors of this report (CSIRO)

Table 2.2 General fishery characteristics (provided by AFMA based on extract from Patterson *et al.* 2020. Fishery Status Reports 2020, ABARES.)

General Fishery Characteristics	
Fishery Name	Southern Bluefin Tuna Fishery
Sub-fisheries	The Australian component of the Southern Bluefin Tuna (SBT) fishery uses the purse seine method (approximately 90% of quota capture), secondary is SBT taken as bycatch by longline and minor line methods in the Eastern Tuna and Billfish Fishery (ETBF) and occasionally in the Western Tuna and Billfish Fishery (WTBF).
Sub-fisheries assessed	This assessment will only consider the dominant purse seine sub-fishery as longline practices are covered under assessments of other Commonwealth fisheries e.g. the Eastern Tuna and Billfish Fishery. The catch of SBT for farming purposes comes under Commonwealth jurisdiction while the farming operations are carried out in waters under South Australian jurisdiction. Therefore, this Ecological Risk Assessment of the Commonwealth fishery encompasses fish capture to the point of transfer to farm cages.
Start date/ history	Troll catches of SBT were reported as early as the 1920s off the east coast of Australia, but significant commercial fishing for SBT commenced in the early 1950s with the establishment of a pole-and-live-bait fishery off New South Wales, South Australia and, later (1970) Western Australia. Purse seine gear overtook pole as the main fishing method and catches peaked at 21,500 t in 1982. The bulk of this early Australian catch of SBT was canned. Following quota reductions in 1983–84, the WA pole fishery for very small juveniles closed and the south-eastern fishery began to target larger juveniles to

	supply the Japanese sashimi market. Surface catches were further reduced between 1989 and 1995 when about half of the Australian total allowable catch (TAC) was taken by Australia–Japan joint venture longliners in the Australian Fishing Zone (AFZ). The joint ventures ceased in late 1995. From 1992 to 1998, domestic longliners operating off Tasmania and NSW also took around 5–10 per cent of the total Australian catch. In 1990–91, about 20 t of SBT were transferred to fattening cages in Port Lincoln, SA, to enhance their value. Since 1992, most of the Australian catch has been taken by purse seine, targeting juvenile southern bluefin tuna (2–5 years) in the Great Australian Bight. This catch is transferred to aquaculture farming operations off the coast of Port Lincoln in South Australia, where the fish are grown to a larger size to achieve higher market prices. Australian longliners operating along the east coast also catch southern bluefin tuna during the winter months. The longline catch has increased in recent years as quota levels have increased. Throughout the rest of its range, southern bluefin tuna is targeted by pelagic longliners from other fishing nations. Recreational angling for southern bluefin tuna in Australia has been popular among game fishers for many years, and activity among the general recreational fishing sector has increased in previous years (for example, Rowsell *et al.* 2008). A survey of recreational fishing for southern bluefin tuna estimated a catch of 270 t with 6% error in 2018–19 (Tracey *et al.* 2020). Based on these results, and other considerations, AFMA amended the SBT Management Plan in 2020 to allow for 5% of Australia's CCSBT allocation to be set aside for mortality associated with recreational fishing for SBT. \
Geographic extent of fishery	The Australian SBT Fishery encompasses SBT fishing operations inside the Australian Fishing Zone (AFZ) (i.e. out to 200 nautical miles around Australia) and on the high seas. An Offshore Constitutional Settlement (OCS) agreement has been reached, which gives AFMA jurisdictional management over SBT in all waters inside the AFZ except in New South Wales State waters. In New South Wales, the State Government has banned the commercial take of SBT inside three nautical miles. Each State has jurisdictional management over the recreational take of SBT. State management measures include bag and size limits. SBT is a highly migratory species and is widely distributed throughout waters of the southern oceans between 30 and 50° south, including the AFZ, but only rarely in the eastern Pacific. The SBT Fishery spans the AFZ. Southern bluefin tuna is targeted by fishing fleets from several nations, both on the high seas and within the Exclusive Economic Zones (EEZs) of Australia, New Zealand, Indonesia and South Africa. Young fish (1–4 years) move from the spawning ground in the north-east Indian Ocean into the Australian EEZ and southwards along the Western Australian coast. Surface-schooling juveniles are found seasonally in the continental-shelf region of southern Australia. Current evidence suggests that juveniles return to the Great Australian Bight in the austral summer, but there is some uncertainty about the proportion that returns (Basson *et al.* 2012). Most of the Australian catch is taken in the Great Australian Bight, with smaller amounts taken from the longline fisheries, mainly off south-eastern Australia.



Catch and effort in the SBTF 2018-19. Inset map of the SBT spawning grounds.

Source: Patterson *et al.* 2020.

Southern Bluefin Tuna fishery high seas fishing zone

The area of water (other than coastal waters and the Australian fishing zone), the boundary of which:

(a) commences on the equator at the point at which the equator is intersected by the meridian of longitude 50º west; and

(b) runs thence east along the equator, to its intersection by the meridian of longitude 140º west; and

(c) runs thence south along that meridian to its intersection by the parallel of latitude 60º south; and

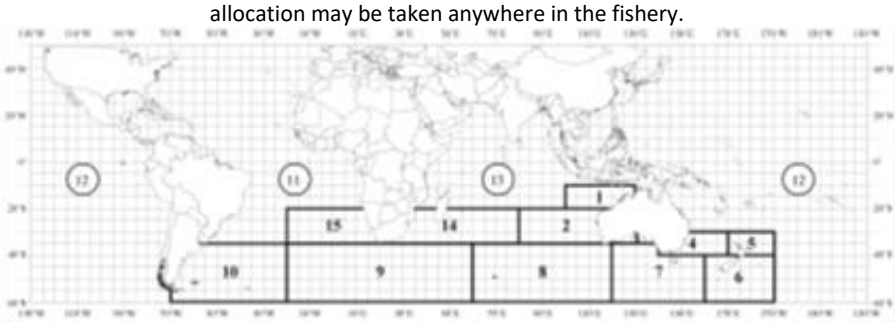
(d) runs thence west along that parallel to its intersection by the meridian of longitude 50º west; and

(e) runs thence north along that meridian to the point of commencement.

Regions or Zones within the fishery

Management of the global SBT fishery is undertaken by the Commission for the Conservation of SBT (CCSBT). SBT are managed as a single stock with a single known spawning ground. CCSBT sets a TAC and determines national allocations for its member countries. The Commission is also responsible for determining management measures and key strategies for the SBT Fishery at the international level. Currently there are eight members of the Extended Commission Australia, European Union, Fishing Entity of Taiwan, Indonesia, Japan, Republic of Korea, New Zealand, South Africa.

CCSBT sets total TAC and determines national allocations for its member countries. The national allocation may be taken anywhere in the fishery.



CCSBT area of competence and statistical areas.

<table>
<tr><td>Fishing season</td><td>Purse seine fishing for SBT occurs from December to April off South Australia, although the quota year runs from 1 December to 30 November each year.

Australian longliners operating along the east coast of Australia also catch southern bluefin tuna during the period May to October.</td></tr>
<tr><td>Key/secondary commercial species and stock status</td><td>Southern Bluefin Tuna (Thunnus maccoyii) are the only species that can be legally landed under the Southern Bluefin Tuna Fishery Management Plan 1995.

“All the key stock status statistics from the 2020 stock assessment are more optimistic than when the last assessment was completed (2017) and the results are consistent with projections made at that time. The relative Total Reproductive Output (TRO) is estimated to be 20% (16-24 80% P.I.). (NB Since 2017, CCSBT has measured reproductive capacity as Total Reproductive Output (TRO) rather than SSB). The stock remains below the level estimated to produce maximum sustainable yield (MSY). There has been improvement since previous stock assessments conducted in 2017 which indicated the stock was at 13% (11-17% 80% PI) of initial biomass. The fishing mortality rate is below the level associated with MSY. The results of sensitivity tests did not show any unusual or unexpected impacts on stock status (median relative TRO is 19-20% across the tests).

The current estimated trends indicate that the stock has been rebuilding by approximately 5% per year since the low point in 2009, and the Management Procedure based rebuilding plan for SBT appears to be on track to achieving the Extended Commission’s objective. Comparison with earlier assessments shows that this trend is consistent with past results. The current TAC was set in 2016 (for the 2018-2020 quota block) following the recommendation obtained from the Bali Management Procedure adopted in 2011.”

CCSBT (2020).</td></tr>
<tr><td>Bait collection and usage</td><td>Bait fishing to support SBT operations occurs largely in coastal regions in the same area. The bait (chum) is used to attract schools of SBT to the capture boats. In recent years most of the chum used in the fishery has been frozen sardines rather than wild caught live fish.

The risks associated with frozen bait are assessed by AQIS and bait bought from Australia is licenced, but some bait is also bought outside Australia. There has been no detection of introduced pathogens resulting from bait or any other means, nor of any adverse consequences on the species or more broadly on the communities.

Southern Bluefin Tuna Statutory Fishing Right conditions allow only the following bait species to be collected in waters relevant to South Australia.

a) Unlimited amounts of the following genera/species Emmelichthys sp., Trachurus sp., Clupea sp., Scomber australasicus and Engraulis sp. for use as live bait for their tuna operations on the boat used for taking the bait; and

b) Up to three tonnes per trip in total of the following genera/species Emmelichthys sp., Trachurus sp., Clupea sp., Scomber australasicus and Engraulis sp. for use as dead bait for their tuna operations on the boat used for taking the bait.

Catches of the bait described above must be for the operators own use as bait and not for sale or for tuna farm feed and can only be taken using one or more of the following gears
• Lampara net
• Lift net; and
• Small scale purse seine.</td></tr>
<tr><td>Current entitlements</td><td>Number of Statutory Fishing Right (SRF) owners 84 owners as at 1 December 2017. Approximately 5-6 purse seine vessels are currently active in any one year. Additional live bait, pontoon towing and feeding vessels are also involved.</td></tr>
<tr><td>Current and recent TACs, quota trends by method</td><td>
<table>
<tr><th>FISHING SEASON</th><th>TOTAL ALLOWABLE CATCH (T)</th><th>CATCH (T) (FARM)</th><th>CATCH (T) (LONGLINE)</th></tr>
<tr><td>2009/10</td><td>4,015</td><td>3,931</td><td>161</td></tr>
<tr><td>2010/11</td><td>4,015</td><td>3,872</td><td>85</td></tr>
<tr><td>2011/12</td><td>4,528</td><td>4,485</td><td>58</td></tr>
<tr><td>2012/13</td><td>4,698</td><td>4,198</td><td>341</td></tr>
</table>
</td></tr>
</table>

2013/14	5,193	5,029	380
2014/15	5,665	4,947	571
2015/16	5,665	4,896	733
2016/17	5,665	4,683	649
2017-18	6,165	5,123	1,034
2018-19	6,165[1]	5,291	783

[1] 119t of under-catch was carried forward bringing the total to 6284 t (Patterson *et al.* 2020).

From 1995 to 2009 Australia's national allocation and subsequent domestic TAC remained at 5,265t however due to concerns about the status of the stock the TAC was reduced to 4,015 tonnes in 2009. Since 2011 the stock has been showing signs of recovery and TACs have been increased in accordance with the CCSBT Management Procedure.

In 2014 members of the CCSBT including Australia, committed to begin to account for all sources of mortality in national fishing allocations by 2018, including recreational catch. In 2020 Australia received an allocation of 6238.4 tonnes for the 2020-21 fishing season. The AFMA Commission set the TAC for the commercial sector at 5926.5 tonnes (95%) setting aside the remaining 5% for the recreational sector.

Current and recent fishery effort trends by method

EFFORT	2014/15	2015/16	2016/17	2017/18	2018/19
Purse Seine search hours	1016	906	1004	1137	1,366
Purse seine shots	154	127	112	198	166

Source: Patterson *et al.* (2016, 2018, 2019, 2020a)

Most of the Australian catch and effort is by purse-seine vessels in the Great Australian Bight and waters off South Australia. The number of vessels in the purse-seine fishery has been relatively stable, ranging from five to eight since the 1994–95 fishing season. Since 2011 most of the catch was taken more to the east of the Bight, closer to Port Lincoln, resulting in shorter towing distances to bring the fish to the aquaculture grow-out cages.

There are no management controls for effort. Effort has fluctuated widely as SBT fishing methods have changed. The overall effect of purse seine fishing has been to reduce the number of boats targeting fish however various support craft including live bait, pontoon-towing and feeding vessels are also involved.

The number of longline vessels fishing for southern bluefin tuna off the south east coast of Australia has been more variable over time. Effort in the longline sector is largely dependent on available quota left after the catching in the farm sector has been completed.

Current and recent fishery catch trends by method

Purse seine vessels take approximately 90% of the Australian SBT quota, with the remainder taken by longline by fishers operating in the Eastern Tuna and Billfish Fishery. The longline catch has increased in recent years as quota levels have increased.

Current and recent value of fishery ($)

In 2018–19, the gross value of production for the SBTF—the combined value of the catch at the point of transfer to farming pens and catch sold direct into global markets—is estimated to have increased by 9% to $43.4 million. The increase in production value was driven by higher catch and an increase in average prices. The increase in catch volume consisted of more southern bluefin tuna being transferred into aquaculture farms as well as increased longline catch. Despite an increase in farm input in 2017–18, a generally declining share of southern bluefin tuna has been ranched in recent years. Conversely, catch from eastern Australia has increased (predominantly caught by the Commonwealth Eastern Tuna and Billfish Fishery fleet).

The average price for southern bluefin tuna increased by 4% in 2018–19, although there has been a longer-run decline in southern bluefin tuna prices. Between 2002–03 and 2018–19, the total

production value of the SBTF declined by 62% in real terms. Most of the decline in gross value of production (GVP) occurred from 2002–03 to 2010–11 as a result of prices falling and a reduction in quota. Since 2010–11, increases in quota have supported GVP in the fishery, with prices remaining below those in 2010–11 in recent years.

For exports, the value of southern bluefin tuna fell by 66% in real terms between 2002–03 and 2018–19, which was the result of a decline in unit export prices (Figure 23.5). Australia's southern bluefin tuna industry is highly export oriented, and the decline in price is the result of a number of related factors, including changes in the Australian dollar – Japanese yen exchange rate, falling demand for sashimi tuna in Japan and growth of global bluefin tuna aquaculture production. (Patterson *et al.* 2020a).

Relationship with other fisheries

SBT quota is also targeted in the Eastern Tuna and Billfish Fishery in the winter months and occasionally caught as bycatch in the Western Tuna and Billfish Fishery.

SBT are also landed by recreational fishers in Australian waters.

Major fisheries that operate in the same region as the Southern Bluefin Tuna Fishery

FISHERY	MAIN TARGET SPECIES	RELATIONSHIP WITH SBT FISHERY
Eastern Tuna and Billfish Fishery	Broadbill swordfish, Yellowfin tuna, Bigeye tuna, Skipjack tuna	SBT taken as byproduct in the fishery, primarily by longline but catch must be covered by SBT quota held under the SBT fishery management plan.
Western Tuna and Billfish Fishery	Broadbill swordfish, Yellowfin tuna, Bigeye tuna, Skipjack tuna	SBT taken as byproduct in the fishery, primarily by longline but catch must be covered by SBT quota held under the SBT fishery management plan.
Small Pelagics Fishery	Jack mackerel, Yellowtail scad, Blue mackerel, Peruvian jack mackerel, Red bait	Species used as food for SBT in fish farms and for chum.
SA Pilchard Fishery	Pilchards	Species used as food for SBT in fish farms and for chum.
WA Pilchard Fishery	Pilchards	Species used as food for SBT in fish farms and for chum.

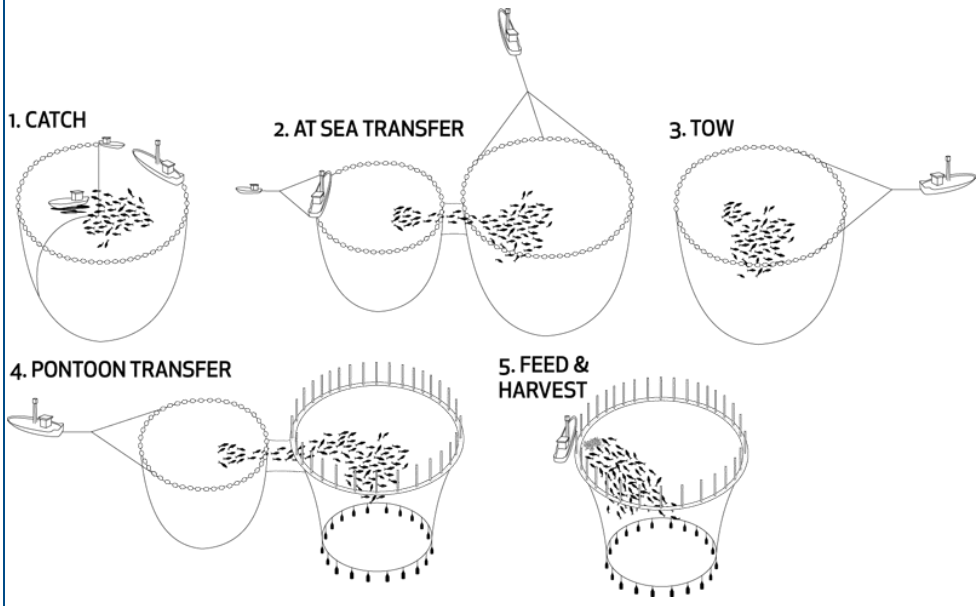
There are other fisheries that overlap the operational area of the SBT Fishery but those mentioned above are principally related to the SBT fishery because they either catch SBT as a byproduct or catch SBT prey species. Recreational fishing and indigenous fishing have been unaccounted for previously, but the Australian Government has announced that 5% of allocation is set aside for recreational fishing (Patterson *et al.* 2020a).

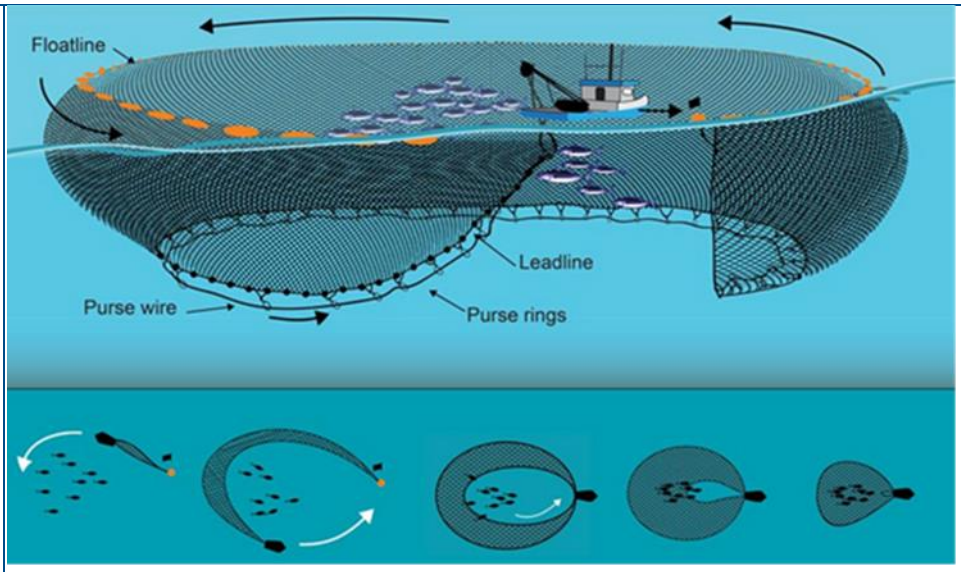
Gear

Fishing methods and gear

The SBT fishery uses the purse seine method. The proximity of the Great Australian Bight (GAB) fishing grounds to Port Lincoln, provides a unique opportunity for sea ranching of SBT. This process involves vessels fishing the GAB from December to April targeting schools of juvenile SBT (age 2 –5 years, 14 – 25 kg) with purse seine.

The purse seine is a large net that is circled around a suitably sized school of SBT (attracted and aggregated by chumming). Rather than landing the fish, the fish are transferred from the purse seine through a net gate to specially designed towing pontoons. The towing pontoons hold 60 – 180 tonnes of SBT that are fed and are towed slowly (1-2 knots) for a period of five to twenty days before reaching Port Lincoln. On arrival to Port Lincoln the SBT are transferred into grow out pontoons (farm cages) anchored to the ocean floor. The SBT are then fattened for several months and sold direct to Japanese markets as frozen or chilled fish.

	A portion of the chum used is taken alive. Bait collection for SBT fishing involves the setting of small purse seine or dip nets. Bait species are listed in scoping document S1.2.  **Tuna ranching process**
Fishing gear restrictions	No gear restrictions
Selectivity of fishing methods	The purse seine method of fishing is very selective as it usually targets only one species at a time. This means that there is very little impact from purse seine fishing on other marine species. Purse seine nets are set near the ocean surface and do not touch the sea floor, so their impact on the marine environment is also very small. https://www.afma.gov.au/fisheries-management/methods-and-gear/purse-seine Furthermore, fishers in the SBT fishery can efficiently locate and target SBT schools with the assistance of aerial spotting, accurate echo-sounders and knowledge of SBT behaviour. SBT tend to school by size, therefore, this method is also inherently size-selective. Once enclosed in the net, the appropriate mesh size avoids fish being gilled and therefore damaged. Few reported interactions with protected species.
Spatial gear zone set	The present fishery takes the bulk of its catch to the east of Kangaroo Island, approximately 35 nm from the mainland (see above: Geographic Extent of Fishery). Prior to 2011, most of the catch was taken near the head of the Great Australian Bight (GAB) on the shelf break.
Depth range gear set	Purse-seine gear used in the fishery usually has a maximum net depth of 120 m and a maximum net length of approximately 900 m. A minimum depth of 50 m is required to set gear.
How gear set	Typically, vessels spend the day searching for ripples (surfacing fish), bird activity and bait schools. Once a patch of suitable fish is located the vessel will approach the patch and start chumming. If the fish are suitable and the patch significant, the purse seine vessel will hand over the chumming to another vessel and prepare to shoot around that chum vessel. Small tender boats and divers are used to position the net and facilitate the capture of the fish. The tow vessel would then position the tow cage alongside the net and divers would carry out a transfer from the purse seine to the tow cage.



Purse seine fishing

Area of gear impact per set or shot	The water column is the only habitat impacted as the net very rarely touches the bottom. The area covered may be several square kilometres.
Capacity of gear	The gear has the capacity to capture schools up to 80 tonnes in weight.
Effort per annum (all boats)	

EFFORT	2015/16	2015/16	2016/17	2017/18	2018/19
Purse Seine search hours	1016	906	1004	1137	1,366
Purse seine shots	154	127	112	198	166

Source: Patterson *et al.* (2016, 2018, 2019, 2020a)

Lost gear and ghost fishing	There is little to no fishing gear loss in this fishery, but it might infrequently occur.
Issues	
Key/secondary commercial species issues & Interactions	**Global Population Issues** "All the key stock status statistics from the 2020 stock assessment are more optimistic than when the last assessment was completed (2017) and the results are consistent with projections made at that time. The relative Total Reproductive Output (TRO) is estimated to be 20% (16-24 80% P.I.). The stock remains below the level estimated to produce maximum sustainable yield (MSY). There has been improvement since previous stock assessments conducted in 2017 which indicated the stock was at 13% (11-17% 80% PI) of initial biomass. The fishing mortality rate is below the level associated with MSY. The results of sensitivity tests did not show any unusual or unexpected impacts on stock status (median relative TRO is 19-20% across the tests). The current estimated trends indicate that the stock has been rebuilding by approximately 5% per year since the low point in 2009, and the Management Procedure based rebuilding plan for SBT appears to be on track to achieving the Extended Commission's objective. Comparison with earlier assessments shows that this trend is consistent with past results. The current TAC was set in 2016 (for the 2018-2020 quota block) following the recommendation obtained from the Bali Management Procedure adopted in 2011." CCSBT (2020) Report of the Twenty Fifth Meeting of the Scientific Committee. **Life history issues**

	The only known breeding area is in the Indian Ocean, south-east of Java, Indonesia. SBT can live for up to forty years, reach a weight of over 200 kilograms, and measure more than 2 metres in length. There is some uncertainty about the size and age when on average they become mature. This is the subject of current research by Commission members. The available data suggests that it is around 1.5 metres and no younger than age 8, research suggests that the age of maturity may in fact be closer to 12 years. CCSBT has undertaken to do further work in this area and is conducting an ageing workshop in May 2019. The aim of the workshop will be to provide training in the method for identification of markers and in staging and scoring of the histology. Following the workshop, statistical analysis will collate the results from the workshop to provide an updated maturity schedule. Mature females produce several million or more eggs in a single spawning period. Breeding takes place from September to April in warm waters south of Java. The young of the year migrate south down the west coast of Australia. During the summer months (December-April), juveniles are found in the coastal waters off the southern coast of Australia and spend their winters in deeper, temperate oceanic waters. After age 5, they are seldom found in near shore surface waters. As SBT breed in the one area (south of Java) and are morphologically similar wherever they are found, they are managed as one breeding stock. **Target bait species** A large volume of fish is required for feeding SBT. The South Australian Sardine Fishery (SASF) was established in 1991 to provide feed for the ranching of southern bluefin tuna. Most of the current TAC is still used as tuna feed. Total catches in the fishery have increased over the last decade in line with total allowable catches for the fishery (30,000 t in 2007 to 38,000 t in 2016). Effort in the fishery has remained relatively stable since 2007. The southern stock of sardine is classified as sustainable as the spawning stock biomass for 2017 is above the target reference point of 150,000 t set in the harvest strategy for the SASF. The majority of chum (mainly sardines) used to attract fish is sourced from the SASF and taken on board vessels frozen. Only a very small percentage of companies use wild caught chum. **Spatial** The majority of the SBT TAC continues to be taken by the purse seine sector in the Great Australian Bight for subsequent grow out by the ranching sector. In recent years, the remainder of the catch has been targeted or taken incidentally, mainly by pelagic longline vessels operating in the Eastern Tuna and Billfish Fishery, with longline catch ranging up to 1000 tonnes annually. The amount taken by longliners on the east coast depends primarily on, access to available quota from the sector and the seasonal availability of fish in the regions fished by longliners in southern NSW. During the winter months when SBT are present off the east coast of Australia, AFMA institutes a restricted access zone to ensure that all incidental catch of SBT by pelagic longliners operating in the ETBF, can be covered by quota. These arrangements include the institution of a core zone established based upon analysis of preferred SBT habitat and additional information from industry and various other sources. In order to access these areas, ETBF operators are subject to minimum quota holding requirements and compulsory e-monitoring. **Resource sharing** Recreational fishing for SBT occurs primarily off south-east TAS, SA, and western VIC. There is also some catch of small SBT off south-west WA. Angling for SBT has been popular among game fishers for many years but has been increasing in popularity in the general recreational fishing sector in recent years (Rowsell *et al.* 2008). Recreational fishing for SBT is managed by the relevant states. States that have a recreational fishing bag limit (number of fish that can be retained) for SBT include SA, VIC, TAS and NSW. SA also has a limit on the number of SBT taken per boat. In 2014, members of CCSBT, including Australia, committed to begin to account for all sources of mortality in national fishing allocations by 2018, including recreational catch. A survey of recreational fishing for southern bluefin tuna estimated a catch of 270 t with 6% error in 2018–19 (Tracey et al. 2020). Based on these results, and other considerations, AFMA amended the SBT Management Plan in 2020 to allow for 5% of Australia's CCSBT allocation to be set aside for mortality associated with recreational fishing for SBT.
Byproduct and bycatch issues and interactions	The SBT Plan does not permit the take of any species other than SBT. If an SBT SFR holder incidentally captures another species when fishing for SBT, they must hold the relevant concession that permits the take of that species. Logbook data supported by scientific observer data demonstrates that the purse seine method of fishing is very selective and results in low bycatch or take of byproduct species.

Protected species issues and interactions	The SBT Plan does not permit the take of any species other than SBT. Logbook data supported by scientific observer data demonstrates that the purse seine method of fishing is very selective and results in low bycatch or take of byproduct species. Skipjack Tuna are sometimes associated with schools of SBT and are occasionally taken in low numbers. SBT are caught in the longline sector of the fishery by boats operating in the ETBF. The take of bycatch and byproduct species is managed through management arrangements for the ETBF. Fishers are required to submit detailed reports of each wildlife interaction within 24 hours of the occurrence. Each report must also include a detailed response to the wildlife interaction which must be implemented immediately by the fisher to minimise the likelihood of similar interactions. The reports are submitted by AFMA to the Protected Species Unit at the Environment Department. **Marine Turtles** There are no recorded (logbook or observer) interactions with marine turtles for tuna purse seine operations within the AFZ. Interactions in the longline sector are reported in accordance with conditions of operators ETBF concessions. **Seabirds** According to logbook and observer records, there have been no actual interactions with seabirds in the SBT Fishery during this assessment. In the ETBF seabirds are managed under the seabird threat abatement plan. **Sharks** Bycatch of sharks during pole-and-line and purse seine fishing (including farm operations) for SBT is minimal. Sharks taken incidentally during purse seining can be released before the net is retrieved and fish are transferred to tow cages. Sharks are known to interact with tow cages containing SBT being towed back to farms, and divers work to release these sharks alive. In 2011, two white sharks were caught in a purse seine operation, resulting in the net being dropped and both sharks being released alive. No observer was present for this interaction and it was not noted in the logbooks. As white sharks are a TEP species in Australia, the interaction was reported to the Department of Sustainability, Environment, Water, Population and Communities as required under the *Environment Protection and Biodiversity Conservation Act 1999*. **Cetaceans and other marine mammals** There have been no logbook or observer reports of purse seine interactions with cetaceans in the Southern Bluefin Tuna purse seine fishery. There have been some anecdotal reports of seals interacting with tow pontoons and lightly with the purse seine net, however, to date there have been no observed fatalities or injuries associated with fishing operations. Based on current information the level of marine mammal interaction with Australian tuna purse seine operations is considered low.
Habitat issues and interactions	Purse seining operations involve the transport of SBT, in towing pontoons, up to 300 km to Port Lincoln that may potentially disrupt pelagic processes. Also involved with purse seining are various chumming and feeding vessels that involve anchoring that may disturb benthic habitat.
Community issues and interactions	No ecological community issues have yet been identified.
Discarding	**Release of fish - immediately after capture** SBT may be released alive and vigorous at the place they were taken immediately after capture, and before any transfer of the fish to a tow cage or another place and will not be deducted from quota if the following details of the release are noted in the AFMA logbook for the vessel: • the weight of fish released; • the location at which the fish were released; and • the reason the fish were released. No devices or net configurations can be used that allow SBT to be released from the tow cage without assistance. Any mortalities that occur during purse seining or towing operations must be accounted for on the appropriate logbooks and are then deducted from quota.
Management: planned and those implemented	

Management objectives	**CCSBT Management Procedure** An MP, known as the "Bali Procedure", was recommended by the CCSBT's Scientific Committee (SC) in July 2011. The Bali Procedure was used to guide the setting of the global SBT TAC for the fishing years from 2012 to 2020 inclusive and it presided over the rebuilding of the stock from approximately 5% of the original spawning biomass in 2010 to approximately 20% in 2020, which is the CCSBT's interim rebuilding target. The CCSBT developed a new MP to guide the setting of TACs for 2021 and onwards. The new MP is known as the "Cape Town Procedure" and incorporates new data series and a new rebuilding objective. The new data series comprise changing the recruitment monitoring series from an aerial survey of juveniles to estimates of two-year old abundance from a gene tagging program and incorporating spawning stock estimates from close-kin mark-recapture. The Cape Town Procedure has recommended the global SBT TAC for 2021 to 2023 inclusive and has the following main management parameters: • The MP is tuned to a 70% probability of rebuilding the stock to the interim rebuilding target reference point of 20% of the original spawning stock biomass by 2035;The MP is tuned to a 50% probability of achieving a biomass level of 30% of the original spawning stock biomass by 2035; • The minimum TAC change (increase or decrease) is 100 tonnes; • The maximum TAC change (increase or decrease) is 3,000 tonnes; • The TAC will be set for three-year periods; and • The national allocation of the TAC within each three-year period will be apportioned according to the Resolution on the Allocation of the Global Total Allowable Catch. **Objectives of the Southern Bluefin Tuna Fishery Management Plan 1995** Objective 1—Efficiency and cost-effectiveness • In managing the SBT Fishery under this Plan, AFMA will pursue the objective of implementing efficient and cost-effective fisheries management on behalf of the Commonwealth Objective 2—Ecologically sustainable development and the precautionary principle • In managing the SBT Fishery under this Plan, AFMA will pursue the objective of ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, in particular, the need to have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment. Objective 3—Maximising net economic returns • In managing the SBT Fishery under this Plan, AFMA will pursue the objective of maximising the net economic returns to the Australian community from the management of the SBT Fishery Objective 4—Accountability • In managing the SBT Fishery under this Plan, AFMA will pursue the objective of ensuring accountability to the fishing industry and to the Australian community for management of fisheries resources. Objective 5—Cost recovery • In managing the SBT Fishery under this Plan, AFMA will pursue the objective of achieving Government targets in relation to the recovery of the costs of AFMA. Objective 6—Implementation of Australia's obligations under international agreements In managing the SBT Fishery under this Plan, AFMA will have regard to the objective of ensuring that conservation and management measures adopted by AFMA implement Australia's obligations under international agreements, including, specifically, obligations in regard to the following matters: (a) fish stocks; (b) fishing activities by Australian-flagged boats on the high seas
Fishery management plan	The *SBT Management Plan 1995* is in place and has been reviewed several times since its inception to ensure it reflects current fishing practices and best risk management strategies.

Input controls	There are no input controls in the fishery.
Output controls	Australia's Southern Bluefin Tuna Fishery (SBTF) is managed through output controls in the form of Individually Transferable Quotas (ITQs) allocated as Statutory Fishing Rights (SFRs) under the SBT Plan. Each year, following the annual meeting of the CCSBT, the Australian Fisheries Management Authority Commission, as the legislative authority, determines a national Total Allowable Catch for the Australian domestic SBTF. Under Australia's SBT Management Plan, the TAC must not exceed Australia's allocation as determined by the CCSBT. Operators are entitled to a share of this TAC based on their SFR holdings. SFRs are tradable throughout the fishing season. This TAC applies to the catch of SBT by all commercial methods and is tradable between sectors.
Technical measures	There are no technical measures applied to the purse-seine fishery. In the ETBF fishery, which catches SBT during the winter months, seasonal area restrictions apply to minimise the risk of non-quota take of SBT by longliners off New South Wales.
Regulations	No regulations are currently in place for the purse seine fishery regarding bycatch and byproduct, TEP, habitat, or communities, beyond those regulations that apply to all fishers (such as no take of protected species).
Initiatives, strategies and incentives	None
Enabling processes	An information and data collection system is in place to ascertain the status of fish stocks in the SBT fishery. Due to the global SBT management arrangements that are in place, Australia has international research and data reporting obligations through CCSBT. As part of the international research effort under the CCSBT, the information collection systems in place in Australia that contribute to international and domestic SBT data collection and monitoring obligations include: **Scientific research – (current)** i) A gene-tagging project for juvenile SBT - managed by CSIRO/CCSBT ii) The Archiving of hard parts for routine ageing and developing age-length keys for the Australian SBT surface fishery – managed by CSIRO iii) A method for estimating the absolute spawning stock size of SBT, using Close-kin genetics – managed by CSIRO iv) Intercessional supporting science to CCSBT scientific Committees – managed by CSIRO v) Evaluation of SBT direct ageing requirements for the Australian longline fishery – managed by CSIRO **Catch Documentation Scheme** In 2008 the CCSBT adopted a resolution instituting a Catch Documentation Scheme (CDS). The resolution came into force as of 1 January 2010. The CDS replaced the export-based Trade Information Scheme (TIS). The aim of the CDS is to prevent SBT caught by Illegal, Unreported and Unregulated (IUU) fishing practices, from entering the market. The CDS also aims to provide an accurate estimate of total catches for monitoring and compliance purposes. The CDS applies to all SBT domestically sold or exported. Under the CDS, each whole fish is required to be tagged, weighed and measured, and have the correct accompanying documentation. Since 1 January 2010, no SBT can be sent for domestic sale, export or accepted for import, without the correct accompanying CDS documentation. Copies of all documents issued and received are provided to the CCSBT Secretariat on a quarterly basis for; compiling into an electronic database, analysis, identification of discrepancies, reconciliation and reporting. This analysis is examined at the annual CCSBT Compliance Committee meeting and issues of non-compliance are raised and discussed. **Audits** At the end of each fishing season AFMA conducts an audit of all farming companies. The level 1 audit includes the following: • monthly breakdowns of receipt and sale of SBT including mortalities;

	• verified counts of SBT conducted during transfer from tow pontoons into farms; • CCSBT CDS figures and domestic sales; and • mortalities recorded by the SBT fish receiver. Each season selected farming companies and wild caught fish receivers also undergo a level 2 audit, aiming to capture in excess of 10% of all commercially landed SBT. This audit includes a full assessment conducted by AFMA officers who review company records which may include spreadsheets, feed boat logs, dive logs, sales and export documentation, including CDS documentation. As part of the level 2 audit, two AFMA officers independently recount all video/DVD recorded by AFMA's agent during the verified count of SBT transferred into those farms included in the audit.
Other initiatives or agreements	Southern Bluefin Tuna were heavily fished by several countries in the past, with the annual catch reaching 80,000 tonnes in the early 1960s. Heavy fishing resulted in a significant decline in the numbers of mature fish and the annual catch began to fall rapidly. In the mid-1980s it became apparent that the SBT stock was at a level where management and conservation was required. There was a need for a mechanism to limit catches. The main nations fishing SBT at the time, Australia, Japan and New Zealand, began to apply strict quotas to their fishing fleets from 1985 as a management and conservation measure to enable the SBT stocks to rebuild. On 20 May 1994 the then existing voluntary management arrangement between Australia, Japan and New Zealand was formalised when the Convention for the Conservation of Southern Bluefin Tuna, which had been signed by the three countries in May 1993, came into force. The Convention created the Commission for the Conservation of Southern Bluefin Tuna. CCSBT sets a global TAC and determines national allocations for its member countries. The Commission is also responsible for determining management measures and key strategies for the SBT Fishery at the international level. Currently there are eight members of the Extended Commission Australia, European Union, Fishing Entity of Taiwan, Indonesia, Japan, Republic of Korea, New Zealand and South Africa.
Data	
Logbook data	Operators fill in catch and effort logbooks while fishing. They are required to send them to AFMA 14 days after the end of each month. The data is entered into AFMA's GENLOG database. **Daily Fishing Logbooks** Daily fishing logbooks are completed by the fisher and are a self-reported record of fishing catch and effort, that are specific to the method employed. The data collected on these logs includes: • Boat/gear details • Vessel masters' details • Bait types • Estimated catch weight per shot • Wildlife Interactions • Carrier boat details • Catcher to tow pontoon transfer details • Estimate of fish weight • Declaration confirming accuracy of data • Net/Pole details • Fishing details • Search details • Towing details • Concession holder declaration • Fishing method • Area fished • Record of all SBT mortalities In the SBT fishery, fish can be caught using a range of methods and each method has a specific logbook. **Catch disposal records** Catch disposal records are used by fisheries managed under the quota system to gather and maintain data on the species caught. On landing, the fishing permit holder, statutory fishing right holder, or a nominated authorised person is required to complete a catch disposal record form detailing the species caught and their accurate weight. In the case of farming operations when SBT are transferred from tow pontoons to the ranching pontoons, a video record must be carried out by the AFMA contracted monitoring company. The video recording is then used to undertake a count of the fish that are transferred into the ranching pontoons. This count forms the basis of a weight estimate that is recorded in the Farm Disposal Record and decremented from quota.

Observer data

An independent observer program has been in place in the purse seine sector since 2002/03. The program aims to meet all domestic observer requirements and the CCSBT requirement to observe at least 10 per cent of the catch and effort.

The purpose of the Observer Program is to provide fisheries managers, research organizations, environmental agencies, the fishing industry and the wider community with independent, reliable, verified and accurate information on the fishing catch, effort and practice of a wide range of boats operating inside, and periodically outside, the Australian Fishing Zone

Observers monitor 100 per cent of all fishing operations while on board. Observers recorded catch composition and fate of target and bycatch species where possible during all observed sets. The time at start and end of observation, the observed catch in estimated number and estimated weight for SBT and all other species were recorded where possible.

Because fish are taken alive for farming purposes in the purse seine sector, it is not possible to obtain actual weight or length information at the time of catching the SBT. Consequently, both catch data and observed catch data are estimates only.

The principal objectives of the observer program are to:

- Monitor and record the day-to-day fishing operations;
- Observe, record and report catch, effort, bycatch and fate of purse seine caught SBT including monitoring tow operations;
- Collect information on the vessel details including; search gear and methods, and fishing gear;
- Collect biological data from fishing operations; and
- Record all interactions and sightings of marine mammals, cetaceans and birds.

YEAR	SECTOR	OBSERVERS DEPLOYED	SEA DAYS	SETS/TOWS OBSERVED	OBSERVED VESSELS	OBSERVED EFFORT (%, UNITS)	OBSERVED CATCH (%, UNITS)
2011–12	Purse Seine	1	17	17 (fish retained) 2 (aborted)	1	11.1% (fish retained)	13.8% (est. total weight)
2011–12	Towing	1	13	1	1	3.4% (tows)	
2012–13	Purse Seine	2	30	14 (fish retained) 1 (aborted)	2	12.7% (fish retained)	13.9% (est. total weight)
2012–13	Towing	2	26	2	2	3.8% (tows)	
2013–14	Purse Seine	2	17	16 (fish retained) 1 (aborted)	2	17.0% (fish retained)	21.9% (est. total weight)
2013–14	Towing	1	9	1	1	4% (tows)	
2014–15	Purse Seine	1	17	14 (fish retained)	1	9.1% (fish retained)	19.9% (est. total weight)
2014–15	Towing	1	20	1	1	4% (tows)	
2015–16	Purse Seine	2	15	25	2	18.9% (fish retained)	20.2% (est. total weight)

	2015–16	Towing	2	21	2	2	7.1% (tows)	
	2016–17	Purse Seine	2	11	20	2	18.3% (fish retained)	16.8% (est. total weight)
	2016–17	Towing	2	18	2	2	9.1% (tows)	
	2017-18	Purse seine	2	37	40	2	20.9% fish retained	19% estimated total weight
	2017-18	Towing	1	20	1	2	3.4% tows	
	2018-19	Purse seine					14.3% shots [1]	

[1] Patterson *et al.* 2020

Other data

Gene Tagging

The CCSBT gene-tagging recruitment monitoring program provides a fishery independent annual abundance estimate of juvenile SBT, from each year of tagging, for use in the SBT operating model and management procedure. Gene-tagging is like conventional tagging but uses the genetic fingerprint of a fish in place of plastic spaghetti tags. The gene-tagging program commenced its first year of tagging at sea in 2016. Gene tagging took over as the primary source of fishery independent recruitment information for the SBT fishery following the cessation of the aerial survey in 2017.

Aerial Survey

The scientific aerial survey had been conducted in the Great Australian Bight since 1993. Fishery independent data collected in the survey was used to estimate a relative abundance index for juvenile SBT for the years 1993-2000 and 2005-2017 (excluding 2015). The aerial survey was ceased in 2017 due to the high cost associated with hiring the aircraft. Gene tagging took over as the primary source of fishery independent recruitment information for the SBT fishery following the cessation of the aerial survey in 2017.

2.2.2 Unit of Analysis Lists (Step 2)

The units of analysis for the sub-fishery are listed by component:

- Species Components (key commercial, byproduct, bycatch and protected components). [Scoping document S2A Species]
- Habitat Component: habitat types. [Scoping document S2B Habitats]
- Community Component: community types. [Scoping document S2C Communities]

The number of units of analysis examined in this report is shown by component in the following Table.

Table 2.3 Number of units of analysis examined in this report

KEY COMMERCIAL	BYPRODUCT	BYCATCH	PROTECTED	HABITATS	COMMUNITIES
1 key, 10 bait	0	25	13	6	5

Scoping Document S2A Species list

Each species identified during the scoping is added to the ERAEF database for further analyses if required. A CAAB code (Code for Australian Aquatic Biota) is required to input the information. The CAAB codes for each species may be found at http://www.marine.csiro.au/caab/

Key, secondary commercial and bait species

This list was compiled by AFMA. Commercial bait refers to any part of the catch which is kept as bait species used in the capture of tuna. This list was compiled by AFMA.

Table 2.4 Key commercial (C1 and CB) species in the Southern Bluefin Tuna purse seine sub-fishery.

ROLE IN FISHERY	TAXA	FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	CAAB CODE	SOURCE
C1	Teleost	Scombridae	*Thunnus maccoyii*	Southern Bluefin Tuna	37441004	AFMA
CB	Teleost	Emmelichthyidae	*Emmelichthys nitidus*	Redbait	37345001	AFMA
CB	Teleost	Carangidae	*Trachurus declivis*	Jack Mackerel	37337002	AFMA
CB	Teleost	Carangidae	*Trachurus novaezelandiae*	Yellowtail Scad	37337003	AFMA
CB	Teleost	Carangidae	*Trachurus murphyi*	Peruvian Jack Mackerel	37337077	AFMA
CB	Teleost	Scombridae	*Scomber australasicus*	Blue Mackerel	37441001	AFMA
CB	Teleost	Clupeidae	*Sardinops sagax*	Australian Sardine	37085002	AFMA
CB	Teleost	Arripidae	*Arripis georgianus*	Tommy Rough	37344001	AFMA
CB	Teleost	Engraulidae	*Engraulis australis*	Australian Anchovy	37086001	AFMA
CB	Teleost	Carangidae	*Pseudocaranx georginanus*	Silver Trevally	37337062	AFMA
CB	Teleost	Carangidae	*Pseudocaranx wrighti*	Skipjack Trevally	37337063	AFMA

Byproduct species

No other species are permitted to be landed.

Bycatch species

Bycatch as defined in the Commonwealth Policy on Fisheries Bycatch 2000 refers to:

- that part of a fisher's catch which is returned to the sea either because it has no commercial value or because regulations preclude it being retained; and
- that part of the 'catch' that does not reach the deck but is affected by interaction with the fishing gear

In the ERAEF method, the part of the key commercial or byproduct catch that is discarded is included in the assessment of the key commercial or byproduct species.

Species were provided by AFMA from logbooks.

Table 2.5 Bycatch species (BC) in the Southern Bluefin tuna purse seine fishery.

ROLE IN FISHERY	TAXA	FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	CAAB CODE	REFERENCE
BC	Invertebrate	Ovalipidae	*Ovalipes australiensis*	Common Sand Crab	28911003	AFMA Observer Logbook
BC	Chondrichthyan	Carcharhinidae	*Carcharhinus brachyurus*	Bronze Whaler	37018001	AFMA Observer Logbook
BC	Chondrichthyan	Squatinidae	*Squatina australis*	Australian Angelshark	37024001	AFMA Observer Logbook
BC	Chondrichthyan	Trygonorrhinidae	*Trygonorrhina fasciata*	Eastern Fiddler Ray	37027006	AFMA Observer Logbook
BC	Chondrichthyan	Urolophidae	*Urolophus viridis*	Greenback Stingaree	37038007	AFMA Observer Logbook
BC	Teleost	Sebastidae	*Helicolenus percoides*	Reef Ocean Perch	37287001	AFMA Observer Logbook
BC	Teleost	Serranidae	*Lepidoperca pulchella*	Eastern Orange Perch	37311001	AFMA Observer Logbook
BC	Teleost	Carangidae	*Pseudocaranx georgianus*	Silver Trevally	37337062	AFMA Observer Logbook
BC	Teleost	Pempheridae	*Pempheris multiradiata*	Bigscale Bullseye	37357001	AFMA Observer Logbook
BC	Teleost	Uranoscopidae	*Ichthyscopus fasciatus*	Banded Stargazer	37400010	AFMA Observer Logbook
BC	Teleost	Scombridae	*Katsuwonus pelamis*	Skipjack Tuna	37441003	AFMA Observer Logbook
BC	Teleost	Aracanidae	*Aracana aurita*	Shaw's Cowfish	37466003	AFMA Observer Logbook
BC	Teleost	Aracanidae	*Capropygia unistriata*	Black-banded Pigmy Boxfish	37466011	AFMA Observer Logbook
BC	Teleost	Diodontidae	*Allomycterus pilatus*	Deepwater Burrfish	37469002	AFMA Observer Logbook

Protected species

Protected species are those species listed as Threatened, Endangered or Protected under the EPBC Act, and those that are listed migratory, marine, cetacean or conservation dependent. They are often poorly listed by fisheries due to low frequency of direct interaction.

There were no records of protected species interactions during the current assessment period but several species were reported by AFMA observers in the Wildlife abundance records and in Observer Reports. These were also included as they were seen to be interacting with the vessel specifically with the chumming operations. Feeding birds were often used as an indication of where SBT were schooling to feed.

Compared to the previous assessment when all species that were reported as potentially occurring within the fishery jurisdiction were listed, this approach has significantly reduced the number of species listed for assessment.

Table 2.6 Protected Species (PS) in the Southern Bluefin Tuna purse seine sub-fishery. Known sightings and/or direct interactions from observer and wildlife logbooks, and observer reports.

ROLE IN FISHERY	TAXA	FAMILY NAME	SCIENTIFIC NAME	COMMON NAME	CAAB CODE	REFERENCE
PS	Marine bird	Procellaridae	*Thalassarche cauta*	Shy Albatross	40040002	AFMA wildlife abundance logbook
PS	Marine bird	Procellaridae	*Thalassarche chrysostoma*	Grey-headed Albatross	40040004	AFMA Observer reports
PS	Marine bird	Procellaridae	*Thalassarche melanophrys*	Black-browed Albatross	40040007	AFMA Observer reports
PS	Marine bird	Procellaridae	*Thalassarche carteri*	Indian yellow-nosed Albatross	40040014	AFMA Observer reports
PS	Marine bird	Procellaridae	*Procellaria aequinoctialis*	White Chinned Petrel	40041018	AFMA Wildlife abundance logbook
PS	Marine bird	Procellaridae	*Puffinus carneipes*	Flesh Footed Shearwater	40041038	AFMA wildlife abundance logbook
PS	Marine bird	Procellaridae	*Puffinus carneipes*	Short-tailed shearwater	40041047	AFMA Observer reports
PS	Marine bird	Hydrobatidae	*Oceanites oceanicus*	Wilsons Storm Petrel	40042004	AFMA Observer reports
PS	Marine bird	Hydrobatidae	*Pelagodroma marina*	White-faced Storm-petrel	40042007	AFMA Observer reports
PS	Marine bird	Sulidae	*Morus serrator*	Australasian gannet	40047002	AFMA Observer reports
PS	Marine bird	Laridae	*Sterna bergii*	Crested Tern	40128026	AFMA Observer reports
PS	Marine mammal	Otariidae	*Arctocephalus forsteri*	New Zealand Fur-seal	41131001	pre-2015 AFMA Wildlife logbook
PS	Marine mammal	Otariidae	*Arctocephalus pusillus doriferus*	Australian Fur Seal	41131003	pre-2015 AFMA Wildlife logbook
PS	Chondrichthyan	Lamnidae	Isurus oxyrinchus	Shortfin Mako	37010001	pre-2015 AFMA Wildlife logbook

Scoping Document S2B1. Benthic Habitats

Since the previous assessments over a decade ago, there has been considerable research and habitat identification and modelling of demersal habitats around Australia and specifically in the SESSF region (Hobday *et al.* 2011; Pitcher *et al.* 2015; Pitcher *et al.* 2016; Williams *et al.* 2009; 2010a, b, c; 2011). This body of work culminated in Pitcher *et al.* (2016) redefining much of the Australian seafloor based on meso-scale surrogates collated from data from biological

surveys, environmental data, protected area/fishery closure data. These new analyses were extended to all continental shelf demersal trawl and dredge fisheries both State and Commonwealth and thus provided a cumulative footprint of all impacting demersal fisheries (Pitcher *et al.* 2018, Mazor *et al.* 2017). The temporal range of the fishery effort data used in these analyses was from 1985 -2012, recently prior to this current assessment period, and is therefore the most relevant to these current habitat assessments. While these analyses and subsequent categorisations are not directly mappable to the original ERA habitat categorisations, they are more comprehensive and repeatable and therefore will be used in all future scoping of habitats.

The assessment of Pitcher *et al.* (2018) was conducted primarily for trawl fisheries but the identification of the vulnerable habitats within assemblages is relevant to any of the other fishing methods in the region. By overlaying the footprint of the fishery to be assessed over the assemblage distribution maps of Pitcher *et al.* (2018), we could identify those containing vulnerable habitats that might be at particular risk (see Table 2.2).

For this assessment of the SBT Purse Seine sub-fishery, we used the region 7 assemblages, identified from Pitcher *et al.* (2018) (**Error! Reference source not found.**) that are overlaid by the footprint of the fishery. The actual footprint of the purse seine fishery is relatively small compared to the whole fishery jurisdiction, so we are only considering the former in this assessment. Of the habitats occurring within the fishery footprint, the most vulnerable types of habitat were originally identified in Williams *et al.* 2011 and Pitcher *et al.* 2016 as habitat–forming benthos in the GAB trawl region and bryozoans on shelf edge in the South East Trawl region. These habitat types now translate to “sensitive habitat-forming biological components” such as bryozoans and sponges from the eastern part of assemblage 21, the most highly exposed assemblage in region 7 (Pitcher *et al.* 2018). Around 45% of this assemblage is estimated to be trawled with <8% closed by way of Marine Reserve. By contrast, the next most exposed assemblage in this region is assemblage 1 (Head of Spencer Gulf) with ~14% swept but 45% area protected from trawling. However, an assessment of the exposure of the sensitive biological components (to trawling) has not been completed (Pitcher *et al.* 2018) and does not allow a rigorous assessment of risk to habitat.

The previous ERAEF assessment of the SBT Purse Seine sub-fishery (Hobday *et al.* 2007a) found that no benthic habitats were vulnerable because it is a midwater method carried out in water depths of between 50 and 120 m. In this assessment, purse seine nets were reported to rarely touch the bottom (AFMA pers. comm.) although observer logs record benthos such as sponges and corals being caught, indicating contact with the bottom did occur, and were assessed as most vulnerable habitat.

The current Purse Seine sub-fishery footprint (not the entire SBT fishery footprint) overlays assemblages 16,17,18 and 19 (Fig 2.1) none of which appear to have identified vulnerable components.

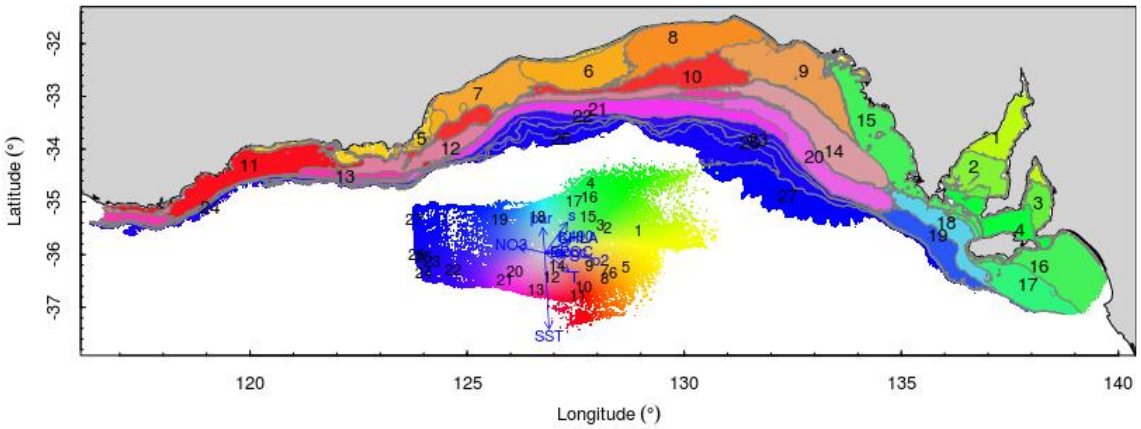


Figure 2.1. Map of the Southern Australian shelf and slope trawl region showing the 27 assemblages derived by Pitcher *et al.* 2018. Each of the assemblages are now used as proxies for habitat in the assessment. (Taken from Pitcher *et al.* 2018).

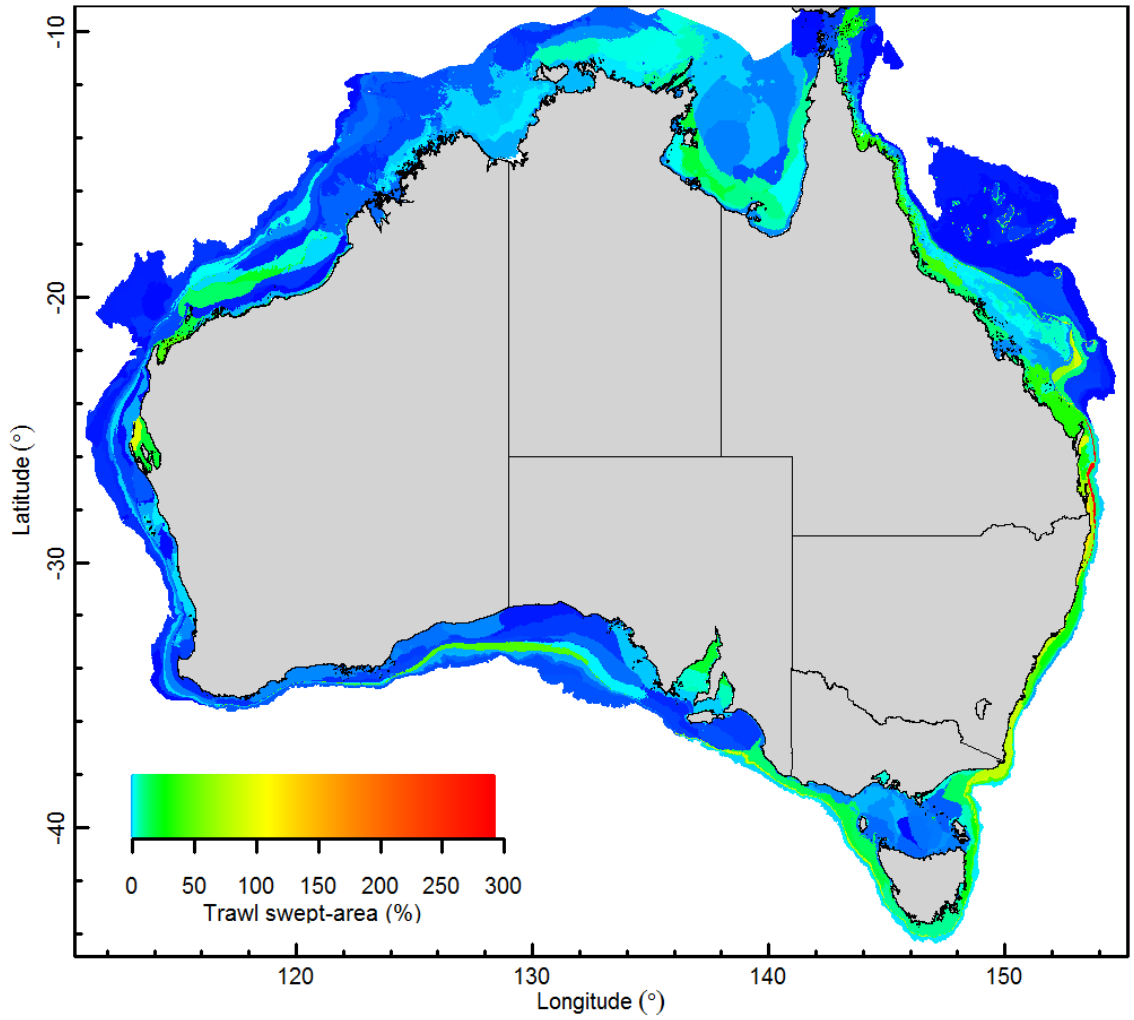


Figure 2.2. Map of assemblages from 0-1500m indicating average annual swept-area by trawling (%) within each assemblage. This is an indicator of relative intensity of trawling. (Taken from Pitcher *et al.* 2018).

Table 2.7. Benthic habitats that occur within the jurisdictional boundary of the Southern Bluefin Tuna purse seine sub-fishery sub-fishery. Shaded cells are those in which fishing occurs. Further details of these assemblages were not available.

Region #	ERAEF Assemblage Number	Habitat type
7	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	
	17	
	18	
	19	
	20	
	21	Sensitive habitat forming biological components e.g. sponges and bryozoans
	22	
	23	
	24	
	25	
	26	
	27	

Scoping Document S2B2. Pelagic Habitats

Table 2.8 Pelagic habitats for the Southern Bluefin Tuna purse seine sub-fishery. Shading denotes habitats occurring within the jurisdictional boundary of the sub-fishery that are subject to effort from purse seining.

ERAEF HABITAT NUMBER	PELAGIC HABITAT TYPE	DEPTH (M)	COMMENTS	REFERENCE
P1	Eastern Pelagic Province - Coastal	0 – 200		2007 ERA
P2	Eastern Pelagic Province - Oceanic	0 –600	this is a compilation of the range covered by Oceanic Community (1) and (2)	2007 ERA
P4	North Eastern Pelagic Province - Oceanic	0 –600	this is a compilation of the range covered by Oceanic Community (1) and (2)	2007 ERA
P5	Northern Pelagic Province - Coastal	0 – 200		2007 ERA
P6	North Western Pelagic Province - Oceanic	0 –800	this is a compilation of the range covered by Oceanic Community (1) and (2)	2007 ERA
P7	Southern Pelagic Province - Coastal	0 – 200	this is a compilation of the range covered by Coastal pelagic Tas and GAB	2007 ERA
P8	Southern Pelagic Province - Oceanic	0 –600	this is a compilation of the range covered by Oceanic Communities (1), (2), and (3)	2007 ERA
P9	Southern Pelagic Province - Seamount Oceanic	0 –600	this is a compilation of the range covered by Seamount Oceanic Communities (1), (2), and (3)	2007 ERA
P10	Western Pelagic Province - Coastal	0 – 200		2007 ERA
P11	Western Pelagic Province - Oceanic	0 –400	this is a compilation of the range covered by Oceanic Community (1) and (2)	2007 ERA
P12	Eastern Pelagic Province - Seamount Oceanic	0 –600	this is a compilation of the range covered by Seamount Oceanic Communities (1) and (2)	
P14	North Eastern Pelagic Province - Coastal	0 – 200		2007 ERA
P15	North Eastern Pelagic Province - Plateau	0 –600	this is a compilation of the range covered by the North Eastern Plateau Community (1) and (2)	2007 ERA
P16	North Eastern Pelagic Province - Seamount Oceanic	0 –600	this is a compilation of the range covered by the Seamount Oceanic Community (1) and (2)	2007 ERA

Scoping Document S2C1. Demersal communities

In ERAEF, communities are defined as the set of species assemblages that occupy the large-scale provinces and biomes identified from national bioregionalisation studies. The biota includes mobile fauna, both vertebrate and invertebrate, but excludes sessile organisms such as corals that are largely structural and are used to identify benthic habitats. The same community lists are used for all fisheries, with those selected as relevant for a fishery being identified based on spatial overlap with effort in the fishery. The spatial boundaries for demersal communities are based on IMCRA boundaries for the shelf, and on slope bioregionalisation for the slope (IMCRA 1998; Last *et al.* 2005). The spatial boundaries for the pelagic communities are based on pelagic bioregionalisation and on oceanography (Condie *et al.* 2003; Lyne and Hayes 2004). Fishery and region-specific modifications to these boundaries are described in detail in Hobday *et al.* (2007) and briefly outlined in the footnotes to the community Tables below.

Table 2.9 Demersal communities which underlie the pelagic communities in the Southern Bluefin Tuna purse seine sub-fishery (✓). Shaded cells indicate all communities within the provinces.

	PROVINCE																			
DEMERSAL COMMUNITY	CAPE	NORTH EASTERN TRANSITION	NORTH EASTERN	CENTRAL EASTERN TRANSITION	CENTRAL EASTERN	SOUTH EASTERN TRANSITION	CENTRAL BASS	TASMANIAN	WESTERN TAS TRANSITION	SOUTHERN	SOUTH WESTERN TRANSITION	CENTRAL WESTERN	CENTRAL WESTERN TRANSITION	NORTH WESTERN	NORTH WESTERN TRANSITION	TIMOR	TIMOR TRANSITION	HEARD & MCDONALD IS	MACQUARIE IS
Inner Shelf 0 – 110m [1,2]										✓									
Outer Shelf 110 – 250m [1,2,]										✓									
Upper Slope 250 – 565m [3]										✓									
Mid–Upper Slope 565 – 820m[3]																			
Mid Slope 820 – 1100m[3]																			
Lower slope/ Abyssal > 1100m[6]																			
Reef 0 -110m[7, 8]																			
Reef 110-250m[8]																			
Seamount 0 – 110m																			

DEMERSAL COMMUNITY	PROVINCE																		
	CAPE	NORTH EASTERN TRANSITION	NORTH EASTERN	CENTRAL EASTERN TRANSITION	CENTRAL EASTERN	SOUTH EASTERN TRANSITION	CENTRAL BASS	TASMANIAN	WESTERN TAS TRANSITION	SOUTHERN	SOUTH WESTERN TRANSITION	CENTRAL WESTERN	CENTRAL WESTERN TRANSITION	NORTH WESTERN	NORTH WESTERN TRANSITION	TIMOR	TIMOR TRANSITION	HEARD & MCDONALD IS	MACQUARIE IS
Seamount 110- 250m																			
Seamount 250 – 565m																			
Seamount 565 – 820m																			
Seamount 820 – 1100m																			
Seamount 1100 – 3000m																			
Plateau 0 – 110m																			
Plateau 110- 250m[4]																			
Plateau 250 – 565m[4]																			
Plateau 565 – 820m[5]																			
Plateau 820 – 1100m[5]																			

1 Four inner shelf communities occur in the Timor Transition (Arafura, Groote, Cape York and Gulf of Carpentaria) and three inner shelf communities occur in the Southern (Eyre, Eucla and South West Coast). At Macquarie Is: 2inner & outer shelves (0-250m), and 3 upper and midslope communities combined (250-1000m). At Heard/McDonald Is: 4outer and upper slope plateau communities combined to form four communities: Shell Bank, inner and outer Heard Plateau (100-500m) and Western Banks (200-500m), 5mid and upper plateau communities combined into 3 trough, southern slope and North Eastern plateau communities (500-1000m), and 6 3 groups at Heard Is: Deep Shell Bank (>1000m), Southern and North East Lower slope/abyssal, 7Great Barrier Reef in the North Eastern Province and Transition and 8 Rowley Shoals in North Western Transition.

Scoping Document S2C2. Pelagic communities

Table 2.10 Pelagic communities in which fishing activity occurs in Southern Bluefin Tuna purse seine sub-fishery (✓). Shaded cells indicate all communities that exist in the province.

PELAGIC COMMUNITY	PROVINCE							
	NORTHEASTERN	EASTERN	SOUTHERN	WESTERN	NORTHERN	NORTHWESTERN	HEARD AND MCDONALD IS2	MACQUARIE IS
Coastal pelagic 0-200m[1,2]			✓					
Oceanic (1) 0 – 600m								
Oceanic (2) >600m								
Seamount oceanic (1) 0 – 600m								
Seamount oceanic (2) 600-3000m								
Oceanic (1) 0 – 200m			✓					
Oceanic (2) 200-600m								
Oceanic (3) >600m								
Seamount oceanic (1) 0 – 200m								
Seamount oceanic (2) 200 – 600m								
Seamount oceanic (3) 600-3000m								
Oceanic (1) 0-400m								
Oceanic (2) >400m								
Oceanic (1) 0-800m								
Oceanic (2) >800m								
Plateau (1) 0-600m								

PELAGIC COMMUNITY	PROVINCE							
	NORTHEASTERN	EASTERN	SOUTHERN	WESTERN	NORTHERN	NORTHWESTERN	HEARD AND MCDONALD IS2	MACQUARIE IS
Plateau (2) >600m								
Heard Plateau 0-1000m[3]								
Oceanic (1) 0-1000m								
Oceanic (2) >1000m								
Oceanic (1) 0-1600m								
Oceanic (2) >1600m								

[1] Northern Province has five coastal pelagic zones (NWS, Bonaparte, Arafura, Gulf and East Cape York) and Southern Province has two zones (Tas, GAB). [2] At Macquarie Is: coastal pelagic zone to 250m. [3] At Heard and McDonald Is: coastal pelagic zone broadened to cover entire plateau to maximum of 1000m.

Table 2.11 Units excluded from PSA lists

TAXA_NAME	SCIENTIFIC_NAME	CAAB_CODE	FAMILY_NAME	COMMON_NAME	EXPLANATION FOR WHY TAXA EXCLUDED
Invertebrate	Spongiidae - undifferentiated	10114000	Spongiidae	Sponges	Lack of taxonomic resolution
Invertebrate	Scyphozoa	11120000	Scyphozoa spp - undifferentiated	Jellyfish	Lack of taxonomic resolution
Invertebrate	Order Scleractinia	11290000	Order Scleractinia - undifferentiated	Stony corals	Attached fauna included in habitat

TAXA_NAME	SCIENTIFIC_NAME	CAAB_CODE	FAMILY_NAME	COMMON_NAME	EXPLANATION FOR WHY TAXA EXCLUDED
Invertebrate	Octopodidae	23659000	Octopodidae - undifferentiated	Octopuses	Lack of taxonomic resolution
Plant	Eukaryota	99000006	Domain Eukaryota - undifferentiated	Algae	Lack of taxonomic resolution
Marine mammal	Otariidae and Phocidae	41132999	Otariidae	Seals	Two species were expanded from this group code.

2.2.3 Identification of Objectives for Components and Sub-components (Step 3)

Objectives are identified for each sub-fishery for the five ecological components (key commercial, bycatch/byproduct, and protected species, habitats, and communities) and sub-components, and are clearly documented. It is important to identify objectives that managers, the fishing industry, and other stakeholders can agree on, and that scientists can quantify and assess. The criteria for selecting ecological operational objectives for risk assessment are that they:

- be biologically relevant;
- have an unambiguous operational definition;
- be accessible to prediction and measurement; and
- that the quantities they relate to be exposed to the hazards.

For fisheries that have completed ESD reports, use can be made of the operational objectives stated in those reports.

Each 'operational objective' is matched to example indicators. Scoping Document S3 provides suggested examples of operational objectives and indicators. Where operational objectives are already agreed for a fishery (Existing Management Objectives), those should be used (e.g. Strategic Assessment Reports). The objectives need not be exactly specified, with regard to numbers or fractions of removal/impact but should indicate that an impact in the sub-component is of concern/interest to the sub-fishery. The rationale for including or discarding an operational objective is a crucial part of the table and must explain why the particular objective has or has not been selected for in the (sub) fishery. Only the operational objectives selected for inclusion in the (sub) fishery are used for Level 1 analysis (Level 1 SICA Document L1.1).

Scoping Document S3 Components and Sub-components: Identification of Objectives

Table 2.12 Objectives for components and sub-components. Operational objectives that have been eliminated are shaded out.

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
Key commercial species	Maintain key commercial stocks at ecologically sustainable levels Avoid recruitment failure of the target species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Maintain biomass above a specified level 1.3 Maintain catch at specified level 1.4 Species do not approach extinction or become extinct	DEPM Biomass, CPUE, yield, Length frequency,	.1 Operational objective too general and covered by (1.2-1.4). 1.2 EMO – Objective 2 of SBT FMP 1995(2013)- to meet stock recovery targets - the CCSBT MP is tuned to a 70% probability of rebuilding the stock to the interim rebuilding target reference point of 20% of the original spawning stock biomass by 2035. 1.3 EMO – Objective 6 SBT FMP 1993- to ensure that conservation and management measures meet international obligations -conservation of the species 1.4 Desirable for fishery to maintain catch at quota
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across known distribution range	2.1 To maintain integrity of natural lifecycle - migration and reproduction. Also Economic penalty to fishery if SBT shift further from port
		3. Genetic diversity	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (Ne), number of spawning units	3.1 Gene-tagging data currently collected for integrating into operating models for MSE
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 There is an optimal fish size range for grow-out cages. Monitoring - Routine otolith and ovary collection to assist in the development of age-length keys for the surface fishery for input into operating

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
					models for stock assessment.
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) 5.2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 Ability of SBT population to sustain fishing depends on ability to repopulate i.e. the level of fecundity of the population. 5.2 Sustainability of population determined by recruitment of new individuals into the fished population.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bate, lights)	6.1 To maintain integrity and functioning of SBT shoal units. Also, penalty to fishery if changes in shoaling or surfacing behaviour occur – fish may be difficult to locate and capture.
Byproduct and Bycatch species	Avoid recruitment failure of the byproduct and bycatch species Avoid negative consequences for species or population sub-components	1. Population size	1.1 No trend in biomass 1.2 Maintain biomass above a specified level 1.3 Maintain catch at specified level 1.4 Species do not approach extinction or become extinct	Biomass, numbers, density, CPUE, yield	1.2 EMO – SBT FMP 1995 (2013) - by-catch is reduced, or kept at, a minimum and below a level that might threaten by-catch species And information is gathered about the impact of the fishery on by-catch species 1.3 Not desirable to maintain biomass of bycatch/byproduct above certain level, the EMO for bycatch/byproduct can be achieved independent of biomass maintenance. 1.4 Not desirable to maintain bycatch/byproduct at specified level for the SBT

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
					Fishery – want to minimise bycatch/byproduct
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space	2.1 Not currently monitored. No specific management objective based on the geographic range of by-catch/by-product species.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Not currently monitored. No reference levels established. No specific management objective based on the genetic structure of by-catch species.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 EMO - Modification of gear selectivity and operational aspects of the SBT fishery to minimise the effects on byproduct / bycatch species (AFMA 2002).
		5 Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1. Beyond the generality of the EMO "Fishing is conducted in a manner that does not threaten stocks of byproduct / bycatch species", reproductive capacity is not currently measured for bycatch/byproduct species and is largely covered by other objectives.
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Purse seine capture and transport methods may attract bycatch species and alter behaviour and movement patterns, resulting in the attraction of species to fishing/tow path areas
Protected species	Avoid recruitment failure of protected species	1. Population size	1.1 No trend in biomass 1.2 Maintain biomass above a specified level 1.3 Maintain catch at specified level	Biomass, numbers, density, CPUE, yield	EMO – SBT FMP 1995(2013) -all reasonable steps are taken to minimise interaction with sea birds, marine reptiles, marine mammals and fish of a kind mentioned in

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
	Avoid negative consequences for protected species or population sub-components Avoid negative impacts on the population from fishing		1.4 Species do not further approach extinction or become extinct		sections 15 and 15A of the Act 1.2 A positive trend in biomass is desirable for TEP species. 1.3 Maintenance of TEP biomass above specified level not currently a fishery operational objective. 1.4 The above EMO states 'must avoid mortality/injury to TEP's'.
		2. Geographic range	2.1 Geographic range of the population, in terms of size and continuity does not change outside acceptable bounds	Presence of population across space, i.e. the GAB	2.1 Change in geographic range of protected species may have serious consequences e.g. population fragmentation and/or forcing species into sub-optimal areas.
		3. Genetic structure	3.1 Genetic diversity does not change outside acceptable bounds	Frequency of genotypes in the population, effective population size (N_e), number of spawning units	3.1 Because population size of protected species is often small, PSs are sensitive to loss of genetic diversity. Genetic monitoring may be an effective approach to measure possible fishery impacts.
		4. Age/size/sex structure	4.1 Age/size/sex structure does not change outside acceptable bounds (e.g. more than X% from reference structure)	Biomass, numbers or relative proportion in age/size/sex classes Biomass of spawners Mean size, sex ratio	4.1 Monitoring the age/size/sex structure of protected species/populations may be a useful management tool allowing the identification of possible fishery impacts and that cross-section of the population most at risk.
		5. Reproductive Capacity	5.1 Fecundity of the population does not change outside acceptable bounds (e.g. more than X% of reference population fecundity) 5.2 Recruitment to the population does not change outside acceptable bounds	Egg production of population Abundance of recruits	5.1 & 5.2 The reproductive capacity of protected species is of concern to the SBT Fishery because potential fishery induced changes in reproductive ability (e.g. reduction in bait fish reduction in seabird brooding success) may have immediate impact on the population size of protected species.

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
		6. Behaviour /Movement	6.1 Behaviour and movement patterns of the population do not change outside acceptable bounds	Presence of population across space, movement patterns within the population (e.g. attraction to bait, lights)	6.1 Purse seine capture and transport methods may attract protected species and alter behaviour and movement patterns, resulting in the attraction of offshore species to inshore areas e.g. great white shark. The overall effect may be to further fragment the population. Fishing operations may also influence the behaviour of calving whales by visual/sound stimuli.
		7. Interactions with fishery	7.1 Interactions between protected species and the fishery are minimised. 7.2 Survival after interactions is maximised 7.3 Interactions do not affect the viability of the population or its ability to recover	Number of interactions Survival rate of species after interactions Number of interactions, biomass or numbers in population	7.1, 7.2, 7.3 EMO - SBT FMP 1995(2013) -all reasonable steps are taken to minimise interaction with sea birds, marine reptiles, marine mammals and fish of a kind mentioned in sections 15 and 15A of the Act
Habitats	Avoid negative impacts on the quality of the environment Avoid reduction in the amount and quality of habitat	1. Water quality	1.1 Water quality does not change outside acceptable bounds	Water chemistry, noise levels, debris levels, turbidity levels, pollutant concentrations, light pollution from artificial light	1.1 The main water quality issue is likely to be related to the feeding of pilchards as SBT in tow cages are bought into port (AFMA 2002). But translocation of pilchard disease may have greatest impact on water quality in GAB.
		2. Air quality	2.1 Air quality does not change outside acceptable bounds	Air chemistry, noise levels, visual pollution, pollutant concentrations, light pollution from artificial light	2.1 Not currently perceived as an important habitat sub-component as purse seine operations not believed to strongly influence air quality.
		3. Substrate quality	3.1 Sediment quality does not change outside acceptable bounds	Sediment chemistry, stability, particle size, debris, pollutant concentrations	3.1 EMO - The fishery is conducted, in a manner that minimises the impact of fishing operations on benthic habitat (AFMA 2002) - The main sediment issues likely to be related to the feeding of pilchards

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
					as SBT in tow cages are bought into port.
		4. Habitat types	4.1 Relative abundance of habitat types does not vary outside acceptable bounds	Extent and area of habitat types, % cover, spatial pattern, landscape scale	4.1 Purse seine operations not perceived to result in change of habitat type frequency.
		5. Habitat structure and function	5.1 Size, shape and condition of habitat types does not vary outside acceptable bounds	Size structure, species composition and morphology of biotic habitats	5.1 Purse seine activities may result in local disruption to pelagic processes
Communities	Avoid negative impacts on the composition/ function/ distribution/ structure of the community	1. Species composition	1.1 Species composition of communities does not vary outside acceptable bounds	Species presence/absence, species numbers or biomass (relative or absolute) Richness Diversity indices Evenness indices	1.1 EMO – Obj 2 SBT FMP1995 (2013) to ensure that the fishery is conducted consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, particularly with regard to the impact on non-target species and the long-term sustainability of the marine environment.
		2. Functional group composition	2.1 Functional group composition does not change outside acceptable bounds	Number of functional groups, species per functional group (e.g. autotrophs, filter feeders, herbivores, omnivores, carnivores)	2.1 The presence/abundance of 'functional group' members may fluctuate widely, however in terms of maintenance of ecosystem processes it is important that the aggregate effect of a functional group is maintained.
		3. Distribution of the community	3.1 Community range does not vary outside acceptable bounds	Geographic range of the community, continuity of range, patchiness	3.1 There may be changes to the geographic extent of pelagic community components due to associated fishing activities.
		4. Trophic/size structure	4.1 Community size spectra/trophic structure does not vary outside acceptable bounds	Size spectra of the community Number of octaves, Biomass/number in each size class Mean trophic level	4.1 Extraction of small pelagic fishes (sardines) may reduce the prey of the higher-level predators potentially resulting in migratory or behavioural shifts in predator species like SBT and seals.

COMPONENT	CORE OBJECTIVE *"What is the general goal?"*	SUB-COMPONENT	OPERATIONAL OBJECTIVES *"What you are specifically trying to achieve"*	INDICATORS *"What you are going to use to measure performance"*	RATIONALE **Rationale flagged as 'EMO' where Existing Management Objective in place**
				Number of trophic levels	
		5 Bio- and geo-chemical cycles	5.1 Cycles do not vary outside acceptable bounds	Indicators of cycles, salinity, carbon, nitrogen, phosphorus flux	5.1 Purse seine and midwater trawl operations not perceived to have a measurable effect on bio and geochemical cycles.

2.2.4 Hazard Identification (Step 4)

Hazards are the activities undertaken in the process of fishing, and any external activities, which have the potential to lead to harm.

The effects of fishery/sub-fishery specific hazards are identified under the following categories:

- capture
- direct impact without capture
- addition/movement of biological material
- addition of non-biological material
- disturbance of physical processes
- external hazards

These fishing and external activities are scored on a presence/absence basis for each fishery/sub-fishery. An activity is scored as a zero if it does not occur and as a one if it does occur. The rationale for the scoring is also documented in detail and must include if/how the activity occurs and how the hazard may impact on organisms/habitat.

Scoping Document S4. Hazard Identification Scoring Sheet

Fishery Name: Southern Bluefin Tuna

Sub-fishery Name: Purse seine sub-fishery

Date: November 2020

Table 2.13 Hazard identification

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	SCORE (0/1)	DOCUMENTATION OF RATIONALE
Capture	Bait collection	1	Capture of small pelagic species with smaller purse seine, lampara or dip nets, for baiting . The SASF is a dedicated fishery for catching sardine for the farming of SBT and provides the majority of (frozen) bait.
	Fishing	1	Capture of species with purse seine nets for farming purposes. SBT not assessed due to higher level stock assessment in CCSBT. Bait species assessed in SPF redbait west, jack mackerel west, are assessed as Tier 1 in the SPF fishery and blue mackerel as Tier 3. Sardine are assessed as Tier 1.
	Incidental behaviour	0	Statutory Fishing Right conditions do not allow the take of any species other than SBT and the permitted bait species. Recreational fishing is specifically banned on SBT vessels.
Direct impact without capture	Bait collection	1	Injury to bait fish that are netted during bait collection activities but not captured, plus the indirect effect of prey food removal on the target species.
	Fishing	1	Disorientation/injury/mortality as a result of momentary entanglement in net but animal may free itself, e.g. dolphin, escaping key commercial species.
	Incidental behaviour	0	As above.
	Gear loss	1	There is little to no major gear loss in this fishery, but it might infrequently occur.
	Anchoring/ mooring	0	Purse seiners operate too far offshore for anchoring and to go to small or major ports during bad weather.
	Navigation/steaming	1	Steaming/navigation (including spotter planes) to find aggregations of SBT may result in collisions (e.g. seabirds or whales vessel interactions), seabird collisions with night-time lights/navigation lights.
Addition/ movement of biological material	Translocation of species	1	The majority of chum (mainly sardines) and feed is sourced from the SASF frozen, but some caught fresh. These fish are local species and are largely consumed by SBT and probably other scavengers. A small proportion might be imported product. There is a risk that diseased fish might be translocated. Hull-fouling is considered as a low probability event but with severe consequences. In general, the consequence levels for this hazard have been scored as only moderate, reflecting an assumed low probability of occurrence, and lack of detection.
	On board processing	0	None.
	Discarding catch	1	Discarding of species captured (dead) occurs including SBT not surviving transport, while majority of species released alive. Some SBT are frozen and returned to port for sampling otoliths.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	SCORE (0/1)	DOCUMENTATION OF RATIONALE
	Stock enhancement	0	None.
	Provisioning	1	Fish being transferred to the grow-out farms are fed frozen sardine, mostly locally sourced from the SASF, during transit.
	Organic waste disposal	1	MARPOL regulations observed - food scraps, paper and cardboard waste were permitted >12nm offshore.
Addition of non-biological material	Debris	0	None observed.
	Chemical pollution	0	None observed.
	Exhaust	1	Vessel introduces exhaust into the environment.
	Gear loss	0	There has been no major gear loss in this fishery for the past decade.
	Navigation/ steaming	1	Purse seine operations involve several vessels navigating to and from fishing grounds including towing transport cages and spotter planes, introducing noise and visual stimuli into the environment, e.g. attraction of foraging/scavenging birds to boats.
	Activity/ presence on water	1	Presence of several vessels, transport cages and spotter planes introduce noise and visual stimuli into the environment.
Disturb physical processes	Bait collection	1	Bait collection using small purse seine may disturb water column processes.
	Fishing	1	Purse seining might disturb/disrupt local physical water flow patterns, e.g. vertical mixing or occasionally hit the bottom.
	Boat launching	0	Not applicable. Vessels in fishery come from designated ports.
	Anchoring/ mooring	0	Purse seiners operate too far offshore for anchoring and to go to small or major ports during bad weather.
	Navigation/ steaming	1	Purse seine operations involve several vessels navigating to and from fishing grounds including towing transport cages and may disturb physical pelagic processes e.g. mixed layer depth (but acknowledged to be trivial).
External Hazards (specify the particular example within each activity area)	Other capture fishery methods	1	SBT caught by long-liners in SBT, ETBF and WTBF. Bait/feed species are caught in SASF and in the SPF. Recreational (charter boat) fisheries. Other fisheries not targeting SBT but operating in the general area are the SET Danish seine and otter trawl, GHAT gillnet, auto longline, and to a lesser degree, demersal longlines, dropline, trap fisheries.
	Aquaculture	1	Farming of tuna, oysters, abalone, finfish, mussels, microalgae and trout occurs from Denial Bay near Ceduna to Lacepede Bay and particularly in Spencer Gulf (https://www.epa.sa.gov.au/soe-2018/coast/pressures-on-the-coast). A range of risks arising from aquaculture activities have been identified including nutrient discharge, chemical use, erosion, sedimentation, stock escapement, disease, marine debris, waste disposal and interactions with the benthos (e.g. disturbance by infrastructure and shading of seagrass). Sardines are specifically caught for SBT aquaculture by the SASF which may lead to increasing pressure on bait fish stocks potentially resulting in localised depletion of natural prey for SBT.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	SCORE (0/1)	DOCUMENTATION OF RATIONALE
	Coastal development	0	Unlikely to impact the purse-seine fishing grounds offshore.
	Other extractive activities	1	Since 1966, 130 seismic surveys have occurred but large-scale 3D surveys in ultra-deep regions of GAB conducted from Nov 2011-June 2012 (45000 km^2) (SA Govt, 2015). Currently, 24 wells drilled throughout the SBT jurisdiction with 13 in the GAB (1972-2003) (Senate Environment and Communications References Committee (2017). Six wells are due west of Kangaroo Island, and near the purse seine fishing grounds. Since 2003 only seismic surveys have been conducted, the last being in 2014-15.
	Other non-extractive activities	1	Coastal shipping may disrupt feeding schools. Three major shipping routes pass through the area of the SBT fishery and may potentially interact with the fish population (Commonwealth of Australia, 2015). The core purse seine area southeast of KI is a military flying and firing zone (Commonwealth of Australia, 2015). Sea floor cables and pipelines fall within the SBT fishery jurisdiction, but, as a pelagic species, SBT interactions are anticipated to be minimal (ERA, 2007).
	Other anthropogenic activities	1	Tourist activities such as whale watching and chartered fishing tours, and recreational fishing. Marine Park Reserves around the Kangaroo Is coast may attract visitors to the near coastal regions.

Table 2.14 Examples of fishing activities (modified from Fletcher *et al.* 2002)

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
Capture		**Activities that result in the capture or removal of organisms. This includes cryptic mortality due to organisms being caught but dropping out prior to the gear's retrieval (i.e. They are caught but not landed)**
	Bait collection	Capture of organisms due to bait gear deployment, retrieval and bait fishing. This includes organisms caught but not landed.
	Fishing	Capture of organisms due to gear deployment, retrieval and actual fishing. This includes organisms caught but not landed.
	Incidental behaviour	Capture of organisms due to crew behaviour incidental to primary fishing activities, possible in the crew's down time; e.g. crew may line or spear fish while anchored, or perform other harvesting activities, including any land-based harvesting that occurs when crew are camping in their down time.
Direct impact, without capture		**This includes any activities that may result in direct impacts (damage or mortality) to organisms without actual capture.**
	Bait collection	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with bait gear during deployment, retrieval and bait fishing. This includes damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but aren't caught.
	Fishing	Direct impacts (damage or mortality) to organisms due to interactions (excluding capture) with fishing gear during deployment, retrieval and fishing. This includes damage/mortality to organisms through contact with the gear that doesn't result in capture, e.g. Damage/mortality to benthic species by gear moving over them, organisms that hit nets but are not caught.
	Incidental behaviour	Direct impacts (damage or mortality) without capture, to organisms due to behaviour incidental to primary fishing activities, possibly in the crew's down time; e.g. the use of firearms on scavenging species, damage/mortality to organisms through contact with the gear that the crew uses to fish during their down time. This does not include impacts on predator species of removing their prey through fishing.
	Gear loss	Direct impacts (damage or mortality), without capture on organisms due to gear that has been lost from the fishing boat. This includes damage/mortality to species when the lost gear contacts them or if species swallow the lost gear.
	Anchoring/ mooring	Direct impact (damage or mortality) that occurs and when anchoring or mooring. This includes damage/mortality due to physical contact of the anchor, chain or rope with organisms, e.g. An anchor damaging live coral.
	Navigation/ steaming	Direct impact (damage or mortality) without capture may occur while vessels are navigating or steaming. This includes collisions with marine organisms or birds.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
Addition/ movement of biological material		**Any activities that result in the addition or movement of biological material to the ecosystem of the fishery.**
	Translocation of species (boat movements, reballasting)	The translocation and introduction of species to the area of the fishery, through transportation of any life stage. This transport can occur through movement on boat hulls or in ballast water as boats move throughout the fishery or from outside areas into the fishery.
	On board processing	The discarding of unwanted sections of key commercial after on board processing introduces or moves biological material, e.g. heading and gutting, retaining fins but discarding trunks.
	Discarding catch	The discarding of unwanted organisms from the catch can introduce or move biological material. This includes individuals of key commercial and byproduct species due to damage (e.g. shark or marine mammal predation), size, high grading and catch limits. Also includes discarding of all non-retained bycatch species. This also includes discarding of catch resulting from incidental fishing by the crew. The discards could be alive or dead.
	Stock enhancement	The addition of larvae, juveniles or adults to the fishery or ecosystem to increase the stock or catches.
	Provisioning	The use of bait or berley in the fishery.
	Organic waste disposal	The disposal of organic wastes (e.g. food scraps, sewage) from the boats.
Addition of non-biological material		**Any activities that result in non-biological material being added to the ecosystem of the fishery, this includes physical debris, chemicals (in the air and water), lost gear, noise and visual stimuli.**
	Debris	Non-biological material may be introduced in the form of debris from fishing vessels or mother ships. This includes debris from the fishing process: e.g. cardboard thrown over from bait boxes, straps and netting bags lost. Debris from non-fishing activities can also contribute to this e.g. Crew rubbish – discarding or food scraps, plastics or other rubbish. Discarding at sea is regulated by MARPOL, which forbids the discarding of plastics.
	Chemical pollution	Chemicals can be introduced to water, sediment and atmosphere through oil spills, detergents other cleaning agents, any chemicals used during processing or fishing activities.
	Exhaust	Exhaust can be introduced to the atmosphere and water through operation of fishing vessels
	Gear loss	The loss of gear will result in the addition of non-biological material, this includes hooks, line, sinkers, nets, otter boards, light sticks, buoys etc.
	Navigation /steaming	The navigation and steaming of vessels will introduce noise and visual stimuli into the environment.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
		Boat collisions and/or sinking of vessels. Echo-sounding may introduce noise that may disrupt some species (e.g. whales, orange roughy)
	Activity /presence on water	The activity or presence of fishing vessels on the water will introduce noise and visual stimuli into the environment.
Disturb physical processes		**Any activities that will disturb physical processes, particularly processes related to water movement or sediment and hard substrate (e.g. boulders, rocky reef) processes.**
	Bait collection	Bait collection may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Fishing	Fishing activities may disturb physical processes if the gear contacts seafloor-disturbing sediment, or if the gear disrupts water flow patterns.
	Boat launching	Boat launching may disturb physical processes, particularly in the intertidal regions, if dredging is required, or the boats are dragged across substrate. This would also include foreshore impacts where fishers drive along beaches to reach fishing locations and launch boats. Impacts of boat launching that occurs within established marinas are outside the scope of this assessment.
	Anchoring /mooring	Anchoring/mooring may affect the physical processes in the area that anchors, and anchor chains contact the seafloor.
	Navigation /steaming	Navigation /steaming may affect the physical processes on the benthos and the pelagic by turbulent action of propellers or wake formation.
External hazards		**Any outside activities that will result in an impact on the component in the same location and period that the fishery operates. The particular activity as well as the mechanism for external hazards should be specified.**
	Other capture fishery methods	Take or habitat impact by other commercial, indigenous or recreational fisheries operating in the same region as the fishery under examination
	Aquaculture	Capture of feed species for aquaculture. Impacts of cages on the benthos in the region
	Coastal development	Sewage discharge, ocean dumping, agricultural runoff
	Other extractive activities	Oil and gas pipelines, drilling, seismic activity
	Other non-extractive activities	Defence, shipping lanes, dumping of munitions, submarine cables

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	EXAMPLES OF ACTIVITIES INCLUDE
	Other anthropogenic activities	Recreational activities, such as scuba diving leading to coral damage, power boats colliding with whales, dugongs, turtles. Shipping, oil spills

2.2.5 Bibliography (Step 5)

All references used in the scoping assessment are included in the References section.

Key documents can be found on the AFMA web page at www.afma.gov.au and include the following:

- SBT Fishery Management Plan 1995 (amended 2013)
- CCSBT Management Procedure
- 2019-20 SBT Fishery Farm Sector pre-season brief

Other publications that provided information:

- SBT Ecological Risk Assessment for Effect of Fishing 2007
- SBT Residual Risk Assessment of Level 2 ERA Species Results 2009
- SBT Ecological Risk Management 2009
- Data summary reports (logbook and observer)
- Fishery Status Report 2020
- Assessment of the Commonwealth SBT Fishery 2019
- Report of the Twenty Fourth Meeting of the Scientific Committee CCSBT.

2.2.6 Decision rules to move to Level 1(Step 6)

Any hazards that are identified at Step 4 Hazard Identification as occurring in the fishery are carried forward for analysis at Level 1.

In this case, 21 out of 26 possible internal activities were identified as occurring in this fishery. Five out of 6 external activities were identified. Thus, a total of 26 activity-component scenarios will be considered at Level 1. This results in 130 total scenarios (of 160 possible) to be developed and evaluated using the unit lists (species, habitats, communities).

2.3 Level 1 Scale, Intensity and Consequence Analysis (SICA)

Level 1 aims to identify which hazards lead to a significant impact on any species, habitat or community. Analysis at Level 1 is for whole components (key commercial; bycatch and byproduct; protected species; habitat; and communities), not individual sub-components. Since Level 1 is used mainly as a rapid screening tool, a “worst case” approach is used to ensure that elements screened out as low risk (either activities or components) are genuinely low risk. Analysis at Level 1 for each component is accomplished by considering the most vulnerable sub-component and the most vulnerable unit of analysis (e.g. most vulnerable species, habitat type or community). This is known as credible scenario evaluation in conventional risk assessment. In addition, where judgments about risk are uncertain, the highest level of risk that is still regarded as plausible is chosen. For this reason, the measures of risk produced at Level 1 cannot be regarded as absolute.

At Level 1 each fishery/sub-fishery is assessed using a scale, intensity and consequence analysis (SICA). SICA is applied to the component as a whole by choosing the most vulnerable sub-component (linked to an operational objective) and most vulnerable unit of analysis. The

rationale for these choices must be documented in detail. These steps are outlined below. Scale, intensity, and consequence analysis (SICA) consists of thirteen steps. The first ten steps are performed for each activity and component, and correspond to the columns of the SICA table. The final three steps summarise the results for each component.

Step1: Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 at the scoping level (Scoping Document S3) onto the SICA table

Step 2: Score spatial scale of the activity

Step 3: Score temporal scale of the activity

Step 4: Choose the sub-component most likely to be affected by activity

Step 5: Choose the most vulnerable unit of analysis for the component e.g. species, habitat type or community assemblage

Step 6: Select the most appropriate operational objective

Step 7: Score the intensity of the activity for that sub-component

Step 8: Score the consequence resulting from the intensity for that subcomponent

Step 9: Record confidence/uncertainty for the consequence scores

Step 10. Document rationale for each of the above steps

Step 11. Summary of SICA results

Step 12. Evaluation/discussion of Level 1

Step 13. Components to be examined at Level 2

2.3.1 Record the hazard identification score (absence (0) presence (1) scores) identified at step 3 in the scoping level onto the SICA Document (Step 1)

Record the hazard identification score absence (0) presence (1) identified at Step 3 at the scoping level onto the SICA sheet. A separate sheet will be required for each component (key commercial, bycatch and byproduct, and protected species, habitat, and communities). Only those activities that scored a 1 (presence) will be analysed at Level 1.

2.3.2 Score spatial scale of activity (Step 2)

The greatest spatial extent must be used for determining the spatial scale score for each identified hazard. For example, if fishing (e.g. capture by longline) takes place within an area of 200 nm by 300 nm, then the spatial scale is scored as 4. The score is then recorded onto the SICA Document and the rationale documented.

Table 2.15 Spatial scale score of activity

<1 NM:	1-10 NM:	10-100 NM:	100-500 NM:	500-1000 NM:	>1000 NM:
1	2	3	4	5	6

Maps and graphs may be used to supplement the information (e.g. sketches of the distribution of the activity relative to the distribution of the component) and additional notes describing the nature of the activity should be provided. The spatial scale score at Step 2 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to spatial scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column of the SICA spreadsheet.

2.3.3 Score temporal scale of activity (Step 3)

The highest frequency must be used for determining the temporal scale score for each identified hazard. If the fishing activity occurs daily, the temporal scale is scored as 6. If oil spillage occurs about once per year, then the temporal scale of that hazard scores a 3. The score is then recorded onto the SICA Document and the rationale documented.

Table 2.16 Temporal scale score of activity

DECADAL (1 DAY EVERY 10 YEARS OR SO)	EVERY SEVERAL YEARS (1 DAY EVERY SEVERAL YEARS)	ANNUAL (1-100 DAYS PER YEAR)	QUARTERLY (100-200 DAYS PER YEAR)	WEEKLY (200-300 DAYS PER YEAR)	DAILY (300-365 DAYS PER YEAR)
1	2	3	4	5	6

It may be more logical for some activities to consider the aggregate number of days that an activity occurs. For example, if the activity "fishing" was undertaken by 10 boats during the same 150 days of the year, the score is 3. If the same 10 boats each spend 30 non-overlapping days fishing, the temporal scale of the activity is a sum of 300 days, indicating that a score of 6 is appropriate. In the case where the activity occurs over many days, but only every 10 years, the number of days by the number of years in the cycle is used to determine the score. For example, 100 days of an activity every 10 years averages to 10 days every year, so that a score of 3 is appropriate.

The temporal scale score at Step3 is not used directly, but the analysis is used in making judgments about level of intensity at Step 7. Obviously, two activities can score the same with regard to temporal scale, but the intensity of each can differ vastly. The reasons for the score are recorded in the rationale column.

2.3.4 Choose the sub-component most likely to be affected by activity (Step 4)

The most vulnerable sub-component must be used for analysis of each identified hazard. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'sub-component' column of the SICA Document. The justification is recorded in the rationale column.

2.3.5 Choose the unit of analysis most likely to be affected by activity and to have highest consequence score (Step 5)

The most vulnerable 'unit of analysis' (i.e. most vulnerable species, habitat type or community) must be used for analysis of each identified hazard. The species, habitats, or communities

(depending on which component is being analysed) are selected from **Scoping Document S2 (A – C)**. This selection must be made on the basis of expected highest potential risk for each 'direct impact of fishing' and 'fishing activity' combination, and recorded in the 'unit of analysis' column of the SICA Document. The justification is recorded in the rationale column.

2.3.6 Select the most appropriate operational objective (Step 6)

To provide linkage between the SICA consequence score and the management objectives, the most appropriate operational objective for each sub-component is chosen. The most relevant operational objective code from **Scoping Document S3** is recorded in the 'operational objective' column in the SICA document. Note that SICA can only be performed on operational objectives agreed as important for the (sub) fishery during scoping and contained in **Scoping Document S3**. If the SICA process identifies reasons to include sub-components or operational objectives that were previously not included/eliminated then these sub-components or operational objectives must be re-instated.

2.3.7 Score the intensity of the activity for the component (Step7)

The score for intensity of an activity considers the direct impacts in line with the categories shown in the conceptual model (**Figure 2**) (capture, direct impact without capture, addition/movement of biological material, addition of non-biological material, disturbance to physical processes, external hazards). The intensity of the activity is judged based on the scale of the activity, its nature and extent. Activities are scored as per intensity scores below.

Table 2.17 Intensity score of activity (Modified from Fletcher *et al.* 2002)

LEVEL	SCORE	DESCRIPTION
Negligible	1	remote likelihood of detection at any spatial or temporal scale
Minor	2	occurs rarely or in few restricted locations and detectability even at these scales is rare
Moderate	3	moderate at broader spatial scale, or severe but local
Major	4	severe and occurs reasonably often at broad spatial scale
Severe	5	occasional but very severe and localized or less severe but widespread and frequent
Catastrophic	6	local to regional severity or continual and widespread

This score is then recorded on the **Level 1 (SICA) Document** and the rationale documented.

2.3.8 Score the consequence of intensity for that component (Step 8)

The consequence of the activity is a measure of the likelihood of not achieving the operational objective for the selected sub-component and unit of analysis. It considers the flow on effects of the direct impacts from Step 7 for the relevant indicator (e.g. decline in biomass below the selected threshold due to direct capture). Activities are scored as per consequence scores below. A more detailed description of the consequences at each level for each component (key commercial, bycatch and byproduct, protected species, habitats, and communities) is provided as a guide for scoring the consequences of the activities in the description of consequences table (see **Table 5** Appendix C).

Table 2.18 Consequence score for ERAEF activities (Modified from Fletcher *et al.* 2002).

LEVEL	SCORE	DESCRIPTION
Negligible	1	Impact unlikely to be detectable at the scale of the stock/habitat/community
Minor	2	Minimal impact on stock/habitat/community structure or dynamics
Moderate	3	Maximum impact that still meets an objective (e.g. sustainable level of impact such as full exploitation rate for a target species).
Major	4	Wider and longer-term impacts (e.g. long-term decline in CPUE)
Severe	5	Very serious impacts now occurring, with relatively long time period likely to be needed to restore to an acceptable level (e.g. serious decline in spawning biomass limiting population increase).
Intolerable	6	Widespread and permanent/irreversible damage or loss will occur-unlikely to ever be fixed (e.g. extinction)

The score should be based on existing information and/or the expertise of the risk assessment group. The rationale for assigning each consequence score must be documented. The conceptual model may be used to link impact to consequence by showing the pathway that was considered. In the absence of agreement or information, the highest score (worst case scenario) considered plausible is applied to the activity.

2.3.9 Record confidence/uncertainty for the consequence scores (Step 9)

The information used at this level is qualitative and each Step is based on expert (fishers, managers, conservationists, scientists) judgment. The confidence rating for the consequence score is rated as 1 (low confidence) or 2 (high confidence) for the activity/component. The score is recorded on the SICA Document and the rationale documented. The confidence will reflect the levels of uncertainty for each score at Steps 2, 3, 7 and 8.

Table 2.19 Description of Confidence scores for consequences.

CONFIDENCE	SCORE	RATIONALE FOR THE CONFIDENCE SCORE
Low	1	Data exists, but is considered poor or conflicting No data exists Disagreement between experts
High	2	Data exists and is considered sound Consensus between experts Consequence is constrained by logical consideration

2.3.10 Document rationale for each of the above Steps (Step 10)

The rationale forms a logical pathway to the consequence score. It is provided for each choice at each Step of the SICA analysis

2.3.11 Level 1 (SICA) Documents

Key commercial species component

Table 2.20 L1.1 - Key commercial species component

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	1	3	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	2	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal waters (State waters) (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec -April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Localised depletion of sardine might impact behaviour /movement of SBT. Intensity> minor- occurs in a relatively confined location, unlikely to be detectable. Consequence> minor- possible detectable change in behaviour/ movement but minimal impact. Confidence > low, no data.
	Fishing	1	4	3	Population size	Southern Bluefin Tuna *Thunnus maccoyii* - assessed under existing	1.2				The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) has management responsibility for SBT across its distribution CCSBT 24th Meeting of SC 2019. AFMA review fishing practices, develop and implement management arrangements that support sustainable fishing operations, including decisions made by the CCSBT. No further action required for this activity.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						stock assessment					
	Incidental behaviour	0									
Direct impact without capture	Bait collection	1	3	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	1	2	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal waters (State waters) (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec -April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Mortality associated with escapement from purse seine causing decrease in population might impact behaviour/movement of SBT. Intensity> minor - nature of the purse-seining operation renders it unlikely to detect any escapement or consequent mortality. Consequence> negligible- unlikely to be detectable against background variability. Confidence > high, low potential for bait fish damage or death independent of capture from this method of capture.
	Fishing	1	4	3	Population size	Southern Bluefin Tuna *Thunnus maccoyii*	1.2	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Escapement from fishing gear may result in physical damage and subsequent mortality but once enclosed in the net, the appropriate mesh size avoids fish

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											being gilled and therefore damaged. Intensity> minor assuming SBT are rarely lost. Consequences> minor - possible detectable changes in size/growth rate (r) but minimal impact on population size and dynamics. Confidence> low, no data.
	Incidental behaviour	0									
	Gear loss	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	3	Population size	Southern Bluefin Tuna *Thunnus maccoyii*	1.2	1	1	2	Navigation /steaming occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Fatal collision with or avoidance of vessel (or towing cages) was considered largest risk. Intensity > negligible remote likelihood of detection of collision with highly mobile SBT. Consequence> negligible - unlikely to detect change in population size against natural variability. Confidence > high – logical.
Addition/ movement of biological material	Translocation of species	1	4	3	Population size	Southern Bluefin Tuna *Thunnus maccoyii*	1.2	3	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Frozen bait is sourced from the SASF and used routinely in fishing operations therefore pathogens or disease could be translocated. Intensity >

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											moderate- chumming occurs during all fishing operations but within restricted area. Consequence> negligible – locally sourced bait reduces risk of introduction of disease and no evidence of pathogen transfer has been detected. Confidence > high-logical, consequences likely to be detectable and serious if had occurred.
	On board processing	0	0	0							
	Discarding catch	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	1.2	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Discarding of dead catch considered most likely to affect behaviour of SBT. Intensity> minor-occurs rarely and in restricted catch area. Consequence> negligible – unlikely to be detectable against variability and return to normal behaviour within hours. Confidence> high, observer and logbook records of discards indicate little discarding.
	Stock enhancement	0									
	Provisioning	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Provisioning by bait attracts SBT to purse seine catching but those not caught unlikely to be affected. Intensity > minor - occurs during all fishing

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											operations but within restricted area and unlikely to be detectable. Consequence> minor – possible detection of change in behaviour but return to normal within days. Confidence > low, no data.
	Organic waste disposal	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disposal of food scraps, paper and cardboard occurs offshore possibly attracting SBT. Intensity> minor – probably occurs daily in small quantities and in restricted area. Consequences> negligible-impact unlikely to be detected and normal behaviour within hours. Confidence> high – reports by observers, MARPOL regulations prohibit other dumping at sea.
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Exhaust emission is mostly gas that enters the atmosphere directly, or just below the surface which may cause SBT to avoid. Dissolving exhaust particulates in the water are diluted very quickly, and the ability to detect considered extremely unlikely. Intensity>negligible- remote likelihood

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											of detection. Consequence >negligible -unlikely to be detectable. Confidence> high - logical.
	Gear loss	0									
	Navigation/ steaming	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	1	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Navigation/ steaming most likely to disrupt behaviour/ movement of SBT from noise or echo sounding in environment. Intensity> minor-occurs while fishing and steaming normally but in immediate vicinity of vessels. Consequence> negligible- unlikely to be differentiated from natural variability in schooling behaviour. Confidence> low, no data.
	Activity/ presence on water	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	3	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Presence on water likely to act as visual stimuli to SBT resulting in disruption of behaviour/movement. Intensity> moderate over total area although vessel presence considered to only impact a small area. Consequence> negligible- behavioural disruptions unlikely to be detectable for SBT species which are highly mobile. Confidence> high-logical.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Disturb physical processes	Bait collection	1	3	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	1	1	2	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal waters (State waters) (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec -April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Disturbance to water column might affect behaviour/movement of SBT. Intensity> negligible- remote likelihood of detection. Consequence> negligible- behavioural disruptions unlikely to be detectable for SBT species which are highly mobile. Confidence > high-logical
	Fishing	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disturbance of water column might affect behaviour/movement of SBT resulting in momentary disruption to feeding and/or movement. Intensity> negligible - fishing considered to only impact physical processes within a small < 1 nm area returning to normal rapidly. Consequence> negligible -any consequence of water column disturbance unlikely to be detectable against normal water flow patterns. Confidence> high- logical consideration of localised disruption of water column impacts highly mobile pelagic species.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	4	3	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disturbance of water (wake formation) from navigation/steaming of fishing vessels was considered not to pose a risk to pelagic species occurring at depth but only to species schooling at the surface. Intensity > negligible - the impact would only be in immediate vicinity of vessel returning to normal within hours. Consequence > negligible with any impact of wake formation unlikely to be detectable. Confidence> high - logical consideration.
External Impacts	Other fisheries- SBT longline sector, Eastern Tuna and Billfish Fishery, recreational, Western Tuna and Billfish Fishery	1	6	5	Population size	Southern Bluefin Tuna *Thunnus maccoyii*	1.2	3	3	2	SBT targeted in the SBT longline fishery sector, Eastern Tuna and Billfish Fishery, and recreational, and incidental in Western Tuna and Billfish Fishery fisheries which occurs nearly daily throughout the whole range of the SBT fishery. Intensity > moderate. Consequence > moderate– TAC is allocated to SFR holders however some mortality is not accounted for i.e. recreational and indigenous (Patterson *et al.* 2020a). Confidence > high, formal stock assessment for

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											SBT despite uncertainty in unaccounted fishing mortality.
	Aquaculture	1	4	6	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	3	2	2	Farming of tuna, oysters, abalone, finfish, mussels, microalgae and trout occurs from Denial Bay to Lacepede Bay particularly in Spencer Gulf (https://www.epa.sa.gov.au/soe-2018/coast/pressures-on-the-coast). Capture of sardine (SASF) from Spencer Gulf and western Eyre Peninsula, specifically for aquaculture of SBT, most likely to deplete wild prey source and therefore impact the behaviour and movement of SBT in the GAB. Modelling in the GAB suggest that maintaining a biomass of small pelagics at >50% B_0 will maintain ecosystem function and health. Current exploitation rate of sardines is ~23% (below limit ref point of 30%) and therefore stock is considered sustainable (https://fish.gov.au/2014-Reports/Australian_Sardine). Intensity> moderate - locally severe. Consequence> minor - possible change in movement but minimal impact on movement of highly mobile SBT movement as sardine depletion is localised. Confidence> high - sardine stocks are assessed regularly and ecosystem modelling studies and movement modelling.
	Coastal development	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Other extractive activities	1	4	6	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	3	2	1	Until 2003, 13 oil wells were drilled in the GAB with half close to purse seine fishing grounds west of Kangaroo Island. Since 2003, only seismic surveys have been conducted. At least 37 species considered to be sensitive to underwater noise pollution including seismic noise (Senate Environment and Communications References Committee 2017) and have been forced away from important habitat. SBT are highly mobile and therefore behaviour/movement most likely to be affected by noise associated with seismic activity and extractive or associated shipping activities. Intensity > moderate – activity occurs across broad area but infrequently in immediate area of fishery. Consequence> minor - possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks. Confidence > low - no data.
	Other non-extractive activities	1	4	6	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	2	1	Coastal shipping may disrupt feeding schools or movement patterns. Three major shipping routes pass through the area of the SBT fishery probably daily (Commonwealth of Australia, 2015). The core Purse Seine area southeast of KI is a military flying and firing zone (Commonwealth of Australia, 2015). Noise may potentially impact SBT behaviour and movement. Intensity> minor as impact of activity confined to small ship

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											surrounds. Consequence> minor unlikely to detect or only in restricted locations. Confidence> low - no data.
	Other anthropogenic activities	1	4	5	Behaviour/ movement	Southern Bluefin Tuna *Thunnus maccoyii*	6.1	2	1	2	Potentially recreational activities such as whale watching, and charter fishing occur in the area but limited by area and season. Small vessels may impact behaviour/movement of SBT from noise or visual stimuli. Intensity > minor, unlikely to be detectable. Consequence> negligible-any change would be undetectable against background variability. Confidence> high - logical.

Byproduct and bycatch component

Table 2.21 L1.2 - Byproduct and bycatch component

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	1	3	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	2	2	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal waters (State waters) (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec -April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Localised depletion of bait species might impact behaviour /movement of skipjack tuna by forcing them to search elsewhere for prey. Intensity> minor - occurs increasingly less often and relatively confined location. Consequence> minor- possible detectable change in behaviour/ movement of skipjack but minimal impact. Confidence > low, no data on bait fish and skipjack interactions.
	Fishing	1	4	3	Population size	Bronze Whaler *Carcharhinus obscurus*	1.2	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Bronze whalers are coastal sharks that feed on schooling small pelagic species like SBT and other tunas. There is no information about abundance, nor any management arrangements. They are rated at extreme risk in the GABT trawl fishery but low in the gillnet. Observers recorded 645 kg (n=5) were caught

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											and discarded during the assessment period. Observer coverage was ~20%, therefore assume that up to 5 animals might be caught annually. Intensity > minor - occurred in restricted locations but impact unlikely to be detectable. Consequence> minor - impact unlikely to affect long-term recruitment dynamics but could affect population size. Confidence> low, observer coverage ~20% of tows, no abundance or population information.
	Incidental behaviour										
Direct impact without capture	Bait collection	1	3	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	2	1	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal waters (State waters) (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec -April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Mortality associated with escapement from purse seine causing decrease in food source might impact behaviour/movement of skipjack tuna. Intensity> minor - nature of the purse-seining operation renders it unlikely to detect any escapement or consequent mortality. Consequence> negligible - skipjack highly mobile and any impact unlikely to be detectable against background variability. Confidence > low, low potential for bait fish damage or death independent of capture from this method of capture but no data.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Fishing	1	4	3	Population size	Skipjack Tuna *Katsuwonus pelamis*	1.2	2	1	1	Fishing occurs largely southeast of Kangaroo Island over an area of 240 x 120nm but focussed in 60 x 60nm area; the main fishing season for SBT is Dec-April. Release from fishing gear might result in physical damage form entanglement and subsequent mortality. Intensity> minor - unlikely to detect post-release mortality. Consequences> negligible – unlikely to detect impact on population size of highly migratory species. Confidence> low, no data.
	Incidental behaviour	0									
	Gear loss	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	3	Population size	Skipjack Tuna *Katsuwonus pelamis*	1.2	1	1	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Fatal collision with vessel/ entanglement with towed cages was considered largest risk to skipjack. Intensity > negligible remote likelihood of detection of collision with highly mobile skipjack. Consequence> negligible - unlikely to detect change in population size against natural variability. Confidence > low – no data.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Addition/ movement of biological material	Translocation of species	1	4	3	Population size	Skipjack Tuna *Katsuwonus pelamis*	1.2	3	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Frozen bait is sourced from the SASF and used routinely in fishing operations therefore pathogens or disease could be translocated. Intensity > moderate - chumming occurs during all fishing operations but within restricted area. Consequence> negligible – using locally sourced fish reduces risk of introduced disease and evidence of pathogen transfer from within the jurisdiction has not been detected therefore no impact on skipjack. Confidence > high- logical, consequences likely to be major if they had occurred.
	On board processing	0									
	Discarding catch	1	4	3	Behaviour/ movement	Bronze Whaler *Carcharhinus obscurus*	1.2	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Discarding of dead catch considered most likely to affect behaviour of sharks through attraction to discarded fish. Intensity> minor - occurs infrequently and in restricted area but over extended time may cause detectable changes. Consequence> minor – unlikely to - impact behaviour and return to normal behaviour within days. Confidence> low, no data.
	Stock enhancement										

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Provisioning	1	4	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Provisioning by bait potentially attracts skipjack and other pelagic species to purse seine catching area but if not caught may remain in area. Intensity > minor - occurs during all fishing operations but within restricted area and unlikely to be detectable. Consequence> minor – possible detectable change in behaviour but return to normal behaviour within days. Confidence > low, no data.
	Organic waste disposal	1	4	3	Behaviour/ movement	Bronze Whaler *Carcharhinus obscurus*	6.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disposal of food scraps, paper and cardboard occurs offshore possibly attracting scavenging sharks. Intensity> minor – probably occurs daily in small quantities and in restricted area. Consequences> negligible - impact unlikely to be detected and normal behaviour within hours. Confidence> high – reports by observers, MARPOL regulations prohibit other dumping at sea.
Addition of non-	Debris	0									
	Chemical pollution	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
biological material	Exhaust	1	4	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Exhaust emission is mostly gas that enters the atmosphere directly, or just below the surface. Skipjack may alter movement to avoid. Intensity>negligible – possibility of detecting exhaust remote. Consequence >negligible -unlikely to be detectable. Confidence> high – logical, mobile species.
	Gear loss	0									
	Navigation/ steaming	1	4	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	2	1	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Navigation/ steaming most likely to disrupt behaviour/ movement of pelagic species such as skipjack from noise or echo sounding in immediate vicinity of vessels. Intensity> minor - occurs while fishing and steaming normally but in proximity of vessels. Consequence> negligible-unlikely to detect variation in movement in highly migratory species. Confidence> low, no data.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Activity/ presence on water	1	4	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	3	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Presence on water likely to act as visual stimuli to pelagic species such as skipjack tuna resulting in avoidance. Intensity> moderate over total area although vessel presence considered to only impact a small area. Consequence> negligible-behavioural disruptions unlikely to be detectable for skipjack. Confidence> high-logical, unlikely to impact highly mobile pelagic species.
Disturb physical processes	Bait collection	1	3	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	1	1	2	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal waters (State waters) (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec -April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Disturbance to water column might affect behaviour/movement of skipjack tuna. Intensity> negligible- remote likelihood of detection. Consequence> negligible- behavioural disruptions unlikely to be detectable for skipjack which are highly mobile. Confidence > high-logical
	Fishing	1	4	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disturbance of water column might affect behaviour/movement of Skipjack tuna resulting in

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											momentary disruption to feeding and/or movement. Intensity> negligible - fishing considered to only impact physical processes within a small < 1 nm area returning to normal rapidly. Consequence> negligible -any consequence of water column disturbance unlikely to be detectable against normal water flow patterns. Confidence> high-logical, localised disruption of water column considered unlikely to impact highly mobile pelagic species.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	4	3	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disturbance of water (wake formation) from navigation/steaming of fishing vessels was considered not to pose a risk to pelagic species occurring at depth but only to species schooling at the surface. Intensity > negligible - the impact would only be in immediate vicinity of vessel returning to normal within hours. Consequence > negligible with any impact of wake formation unlikely to be detectable. Confidence> high - logical consideration.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
External Impacts	Other fisheries: Skipjack Tuna Fishery, ETBF, WTBF	1	6	5	Population size	Skipjack Tuna *Katsuwonus pelamis*	6.1	3	2	2	Skipjack has not been targeted in the Skipjack Tuna Fishery since 2008/9 but may be a secondary target in Eastern Tuna and Billfish Fishery, Western Tuna and Billfish Fishery (no restrictions) which occur daily throughout the whole range of the SBT fishery. The Western and Central Pacific Fisheries Commission and the Indian Ocean Tuna Commission are responsible for managing the international catch of skipjack tuna overall. Intensity > moderate. Consequence > minor– no fishing mortality on stocks in purse seine area. Confidence > high - formal assessments.
	Aquaculture	1	4	6	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	3	2	2	Farming of tuna, oysters, abalone, finfish, mussels, microalgae and trout occurs from Denial Bay to Lacepede Bay particularly in Spencer Gulf (https://www.epa.sa.gov.au/soe-2018/coast/pressures-on-the-coast). Capture of sardine (SASF) from Spencer Gulf and western Eyre Peninsula, specifically for aquaculture of SBT, most likely to deplete wild prey source and therefore impact the behaviour and movement of SBT in the GAB. Modelling in the GAB suggest that maintaining a biomass of small pelagics at >50% B_0 will maintain ecosystem function and health. Current exploitation rate of sardines is ~23% (below limit

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											ref point of 30%) and therefore stock is considered sustainable (https://fish.gov.au/2014-Reports/Australian_Sardine). Intensity> moderate - locally severe. Consequence> minor - possible change in movement but minimal impact on movement of highly mobile pelagic species as sardine depletion is localised. Confidence> high - sardine stocks are assessed regularly, trophic and ecosystem modelling studies.
	Coastal development	0									
	Other extractive activities	1	4	6	Behaviour/movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	3	2	1	Until 2003, 13 oil wells were drilled in the GAB with half close to purse seine fishing grounds west of Kangaroo Island. Since 2003, only seismic surveys have been conducted. At least 37 species considered to be sensitive to underwater noise pollution including seismic noise (Senate Environment and Communications References Committee 2017) and have been forced away from important habitat. Skipjack tuna are highly mobile and therefore behaviour/movement most likely to be affected by noise associated with seismic activity and extractive or associated shipping activities. Intensity > moderate – activity occurs across broad area but infrequently in immediate area of fishery. Consequence> minor - possible detectable change in behaviour/ movement but minimal impact on population dynamics. Time to return to original behaviour/ movement on the scale of days to weeks. Confidence > low - no data.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Other non-extractive activities	1	4	6	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	2	2	1	Coastal shipping may disrupt feeding schools or movement patterns. Three major shipping routes pass through the area of the SBT fishery probably daily (Commonwealth of Australia, 2015). The core purse seine area southeast of KI is a military flying and firing zone (Commonwealth of Australia, 2015). Noise may potentially impact SBT behaviour and movement. Intensity> minor as impact of activity confined to small ship surrounds. Consequence> minor, unlikely to detect or only in restricted locations. Confidence> low - no data.
	Other anthropogenic activities	1	4	5	Behaviour/ movement	Skipjack Tuna *Katsuwonus pelamis*	6.1	2	1	2	Potentially recreational activities such as whale watching, and charter fishing occur in the area but limited by area and season. Small vessels may impact behaviour/movement of SBT from noise or visual stimuli. Intensity > minor, unlikely to be detectable. Consequence> negligible-any change would be undetectable against background variability. Confidence> high - logical.

Protected species component

Table 2.22 L1.3 – Protected species component

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	1	3	3	Behaviour/ movement	Flesh-footed Shearwater *Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	6.1	2	2	2	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters. The main fishing season for SBT is Dec - April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Localised depletion of sardine might impact behaviour /movement of shearwaters and albatross. Intensity> minor- infrequent and in a confined location to be detectable. Consequence> minor- no detectable change in behaviour/ movement. Time to return to original behaviour/ movement is hours. Confidence > high, observers report normally birds feed where tuna are schooling and depart once bait dispersed.
	Fishing	1	4	3	Interactions with fishery	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed	1.4	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Purse seining is highly selective specifically targeting SBT. On the occasion that marine mammals or sharks are enclosed in the net, they are released by lowering an edge of the net. Intensity > minor-

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Fur Seal *Arctocephalus forsteri*					occurs infrequently and in restricted range of population. Consequences> negligible – no deaths reported. Confidence> high, all interactions must be reported.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	1	3	3	Behaviour/ movement	Flesh-footed Shearwater *Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	6.1	2	2	2	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Increased mortality from escapement from purse-seine might impact behaviour /movement of seabirds as attractant. Intensity > minor - nature of the purse-seining operation renders it unlikely to detect any escapement or consequent mortality. Consequences> minor- no detectable change in behaviour/ movement reported, hours to return to normal. Confidence>high, observers report birds return to normal behave quickly.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Fishing	1	4	3	Interactions with fishery	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal *Arctocephalus forsteri*	7.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Purse seining is highly selective specifically targeting SBT. Anecdotal reports of non-fatal/non-injurious interactions of seals with the seine nets and tow pontoons. Fishing/towing activities might cause entanglement. Intensity > Intensity > minor- occurs infrequently and in restricted range of population. Consequences> minor- few interactions and involving up to 5% of population. Confidence> high, all interactions must be reported.
	Incidental behaviour	0									
	Gear loss	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	3	Interactions with fishery	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed	7.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. A collision with vessel or entanglement with towing cages during steaming was considered largest risk to fur seals that might be attracted to fishing operations and caged fish. Intensity > minor- occurs rarely

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Fur Seal *Arctocephalus forsteri*					and in restricted range of population. Consequence> minor- few anecdotal interactions, <5% of population. Confidence > high– all interactions must be reported although non-fatal interactions unlikely to be reported.
Addition/ movement of biological material	Translocation of species	1	4	3	Behaviour / movement	Flesh-footed Shearwater *Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	6.1	3	1	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Frozen bait is sourced from the SASF and used routinely in fishing operations therefore could attract birds to activities. Intensity > moderate - chumming occurs during all fishing operations but within restricted area. Consequence> negligible– no detectable persistent change in behaviour/ movement. Time to return to original behaviour/ movement on the scale of hours. Confidence > low - no information.
	On board processing	0	0	0							
	Discarding catch	1	4	3	Interactions with fishery	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal	7.1	2	2	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Discarding of dead catch considered most likely to affect behaviour of fur seals. Intensity> minor-occurs rarely and in restricted area of population. Consequence> minor-few interactions and involving up to

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Arctocephalus forsteri					5% of population. Confidence> high, observer and logbook records.
	Stock enhancement	0									
	Provisioning	1	4	3	Interactions with fishery	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal *Arctocephalus forsteri*	7.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Provisioning/baiting and feeding of towed SBT attracts fur seals activities. Intensity > minor - occurs during all fishing operations but within restricted area of seal population. Consequence> minor – few interactions and involving up to 5% of population. Confidence> high, records of interactions must be recorded.
	Organic waste disposal	1	4	3	Behaviour / movement	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal *Arctocephalus forsteri*, Flesh-footed Shearwater-	6.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disposal of food scraps, paper and cardboard occurs offshore possibly attracting fur seals and seabirds. Intensity> minor – probably occurs daily in small quantities and in restricted area. Consequences> negligible-impact unlikely to be detected and normal behaviour within hours. Confidence> high – observers report on MARPOL regulations.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Puffinus carneipes					
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	4	3	Behaviour / movement	Flesh-footed Shearwater-*Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	6.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Exhaust emission is mostly gas that enters the atmosphere directly, or just below the surface. Birds most likely to be affected but within immediate vicinity of vessels. Intensity> minor- few interactions and most likely brief. Consequence> negligible -no detectable changes in behaviour reported. Confidence> high – observers do not report interactions.
	Gear loss	0									
	Navigation/ steaming	1	4	3	Behaviour/ movement	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed	6.1	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Navigation/ steaming introduces noise or echo sounding into the environment possibly affecting marine mammal distribution. Cetaceans such as blue whales are among at least 37 species considered to be

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Fur Seal *Arctocephalus forsteri*					sensitive to underwater noise pollution (Senate Enquiry 2017) and have been forced away from important habitat. Intensity> minor-noise etc confined to vicinity of vessels therefore restricted location. Consequence> minor- no interactions resulting in persistent change to behaviour/ movement, return to normal in hours. Confidence> low-no data.
	Activity/ presence on water	1	4	3	Behaviour/ movement	Flesh-footed Shearwater *Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	6.1	2	2	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Presence on water likely to act as visual & olfactory stimuli to seabirds resulting in disruption of behaviour/movement. Intensity> minor vessel presence considered to only impact a small area. Consequence> minor- no detectable change in behaviour/ movement and time to return to original behaviour/ movement on the scale of hours. Confidence> high-observers report behaviour of seabirds return to normal quickly.
Disturb physical processes	Bait collection	1	3	3	Behaviour/ movement	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal	6.1	1	1	2	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Fresh bait collection less common due increased use of frozen bait sourced from the SASF. Disturbance to water column might affect behaviour/movement of fur seals. Intensity> negligible- remote likelihood of detection.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Arctocephalus forsteri					Consequence> negligible- behavioural disruptions unlikely to be detectable for fur seals which are highly mobile. Confidence > high-logical.
	Fishing	1	4	3	Behaviour/ movement	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal *Arctocephalus forsteri*	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disturbance of water column might affect behaviour/movement of fur seals resulting in momentary disruption to feeding and/or movement. Intensity> negligible - fishing considered to only impact physical processes within a small < 1 nm area returning to normal rapidly. Consequence> negligible - detectable change in behaviour/ movement unlikely to be detectable against normal water flow patterns. Confidence> high-logical consideration of localised disruption of water column impacts highly mobile pelagic species.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	3	Behaviour/ movement	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed	6.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disturbance of water (wake formation) from navigation/steaming of fishing vessels was considered to pose a risk to fur seals or dolphins. Intensity > negligible - the impact would only be in immediate

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						Fur Seal *Arctocephalus forsteri*					vicinity of vessels. Consequence> negligible – no persistent change in behaviour, return to normal within hours. Confidence> high - no interactions with seals reported.
External Impacts	Other fisheries: ETBF, WTBF, SBT longline, recreational	1	6	5	Population size	Flesh-footed Shearwater *Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	1.4	3	3	2	Within the SBT fishery, the longline sector, Eastern Tuna and Billfish Fishery, Western Tuna and Billfish Fishery and recreational fisheries occur nearly daily throughout the whole range of the SBT fishery. Seabirds most likely to be directly interacting with these fisheries. Intensity > moderate - occurs broadly across southern Australia but much less in area of purse seine fishery. Consequence > moderate - possible detectable change in size/ growth rate but minimal impact on population size and none on dynamics of sooty shearwaters. Confidence > high- interactions must be reported, and seabird threat abatement plans, and devices exist for these longline fisheries.
	Aquaculture	1	4	6	Population size	Flesh-footed Shearwater *Puffinus carneipes*, Shy Albatross *Thalassarche cauta*	1.4	3	4	1	Farming of tuna, oysters, abalone, finfish, mussels, microalgae and trout occurs from Denial Bay to Lacepede Bay particularly in Spencer Gulf (https://www.epa.sa.gov.au/soe-2018/coast/pressures-on-the-coast). Capture of sardine (SASF) from Spencer Gulf and eastern Eyre Peninsula, specifically for aquaculture of SBT, most likely to deplete wild prey source and therefore impact population size of seabirds

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											specifically flesh footed shearwaters i.e. by a reduced reproductive potential from increased searching area. Intensity => moderate –at broader spatial scale or locally severe in the SASF. Consequence> major – could affect local populations of seabirds. Confidence > low-insufficient knowledge on dynamics between bait fish and seabirds.
	Coastal development	0									
	Other extractive activities	1	4	6	Behaviour/movement	Australian Fur Seal *Arctocephalus pusillus doriferus*, Long-nosed Fur Seal *Arctocephalus forsteri*	6.1	3	2	1	Until 2003, 13 oil wells were drilled in the GAB with half close to purse seine fishing grounds west of Kangaroo Island. Since 2003, only seismic surveys have been conducted. Cetaceans such as blue whales are among at least 37 species considered to be sensitive to underwater noise pollution including seismic noise pollution (Senate Environment and Communications References Committee 2017) and have been forced away from important habitat. Behaviour/movement of cetaceans most likely to be affected by noise associated with seismic activity and extractive or associated shipping activities. Intensity > moderate – activity occurs across broad area but infrequently in immediate area of fishery. Consequence> minor - possible detectable change in behaviour/ movement but minimal impact on population dynamics.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											Time to return to original behaviour/ movement on the scale of days to weeks. Confidence > low – no data.
	Other non-extractive activities	1	4	6	Behaviour/ movement	Flesh-footed shearwater *Puffinus carneipes*, Shy albatross *Thalassarche cauta*	6.1	2	2	1	Coastal shipping may disrupt feeding schools or movement patterns. Three major shipping routes pass through the area of the SBT fishery probably daily (Commonwealth of Australia, 2015). The core purse seine area southeast of KI is a military flying and firing zone (Commonwealth of Australia, 2015). Noise & visual stimuli may potentially impact seabird behaviour and movement. Intensity> minor as impact of activity confined to small ship surrounds. Consequence> minor unlikely to detect or only in restricted locations. Confidence> low-no data.
	Other anthropogenic activities	1	4	5	Behaviour/ movement	Australian fur seal *Arctocephalus pusillus doriferus*, Long-nosed fur seal *Arctocephalus forsteri*	6.1	2	1	1	Potentially recreational activities such as whale watching, and charter fishing occur in the area but limited by area and season. Small vessels may impact behaviour/movement of marine mammals and cetaceans from noise or visual stimuli. Intensity > minor, unlikely to be detectable. Consequence> negligible-any change would be undetectable against background variability, return to normal behaviour in hours. Confidence> low -no data.

Habitat component

Table 2.23 L1.4 - Habitat component

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Capture	Bait collection	1	3	3	Habitat structure and function	Assemblages 16 & 17	1.1	2	2	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Nets may touch the bottom picking up attached benthos altering habitat structure. Intensity> minor – fresh bait collection less common and reported to rarely touch bottom. Consequence> minor- possible detectable impact, recovery in habitats in regions of high natural disturbance (i.e. currents, tides, storm swell) days to weeks. Confidence> low-the effect of transient and relatively light bottom contact in inner shelf depths, not known and no observer data on bait seining operations.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Fishing	1	4	3	Habitat structure and function	Assemblages 16 & 17	1.1	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Most fishing over assemblage 16 & 17. Removal of attached benthos in assemblage 16 & 17 considered most likely risk to habitat structure and function. Intensity > minor – purse seines inherently midwater gear, reported to rarely hit bottom. Consequence> minor - possible detectable impact, recovery in habitats in regions of high natural disturbance (i.e. currents, tides, storm swell) days to weeks. Confidence> low - gear loss reported although minor interactions are not, and observer records indicate benthos in catch composition.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	1	3	3	Substrate quality	Assemblages 16 & 17	1.1	2	1	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Fresh bait collection decreasing due to increased use of frozen bait sourced from the SASF. Substrate quality of Assemblage 16 & 17 may be altered temporarily from impact of net during bait collection, as re-suspension

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											of fine sediments create turbidity until settle out. Intensity > minor – purse seines inherently midwater gear and bait collection has decreased. Consequence> negligible - unlikely to detectable impact, recovery in habitats in regions of high natural disturbance (i.e. currents, tides, storm swell) hours to days. Confidence> low - the effect of transient and relatively light bottom contact in inner shelf depths, not known and no observer data on bait seining operations.
	Fishing	1	4	3	Substrate quality	Assemblages 16 & 17	1.1	2	2	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Substrate quality of over Assemblage 16 & 17 may be altered temporarily from impact of net as re-suspension of fine sediments create turbidity until settle out. Pelagic habitat considered uncatchable. Intensity> minor – purse seines inherently midwater gear, reported to rarely hit bottom. Consequence> minor - possible detectable impact, recovery in habitats in regions of high natural disturbance (i.e. currents, tides, storm swell) days to weeks. Confidence> low - gear losses are reported although minor interactions are not, and observer records indicate benthos in catch composition.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Incidental behaviour	0									
	Gear loss	0									
	Anchoring/ mooring	0									
	Navigation/steaming	1	4	3	Water quality	Southern Pelagic Province-coastal (P7)	2.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. The pelagic water quality of the Southern Coastal Pelagic habitat may change with increased turbulence and changes in water mixing that could occur from movement of vessels through water. Intensity> minor - unlikely to detect impact. Consequence> negligible - remote likelihood of detection. Confidence > high - pelagic habitat considered to quickly return to pre-disturbed structure and resistant to purse seine fishing operations.
Addition/ movement of biological material	Translocation of species	1	4	3	Water quality	Southern Pelagic Province-coastal (P7)	2.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Chumming & feeding SBT with locally sourced fresh or frozen pilchards from the SASF occurs daily during 3-month fishing season. Translocation of species may pose risk of disease

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											being transferred and altering pelagic water quality of the Southern Coastal Pelagic habitat may change due to increased disease load. Intensity > minor - low viral persistence time. Consequence> negligible time for water quality to recover though dilution on scale of hours. Confidence > high - viral persistence generally on scale of hours.
	On board processing	0	0	0							
	Discarding catch	1	4	3	Substrate quality	Assemblages 16 & 17	1.1	2	1	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Discarding byproduct species on outer edge of shelf assemblages 16 & 17 might affect substrate quality. Intensity> minor- occurs rarely and in restricted location, discards would be largely consumed by scavenging species, and localized accumulation unlikely. Unlikely to detect impact. Consequence> negligible-unlikely to detect impact of any sort. Confidence> low - insufficient knowledge on fate of discards.
	Stock enhancement	0									
	Provisioning	1	4	3	Substrate quality	Assemblages 18 & 19	1.1	2	1	1	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											season for SBT is Dec -April. Provisioning by baiting and feeding SBT in tow cages might result in wasted bait over Assemblages 18 & 19. Intensity> minor- occurs in restricted location. Consequence> negligible-excess feed would be largely consumed by scavenging species, and localized accumulation unlikely to detect impact of any sort. Confidence> low - insufficient knowledge on fate of discards.
	Organic waste disposal	1	4	3	Water quality	Southern coastal pelagic province	2.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disposal of food scraps, paper and cardboard occurs offshore but unlikely to affect water quality. Intensity> minor- occurs in restricted location. Consequences> negligible- impact unlikely to be detectable. Confidence>high, no known impacts from organic waste disposal and tightly regulated by MARPOL.
Addition of non-biological material	Debris	0									
	Chemical pollution	0									
	Exhaust	1	4	3	Air quality	Southern Pelagic Province-coastal (P7)	3.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Exhaust from running engines may impact the air quality of the species

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											within Southern Coastal Pelagic habitat. Intensity> negligible. Consequence> negligible due to rapid dispersal of pollutants in winds, and likely to be physically undetectable over very short time frames. Confidence > high - effect of exhaust is very localised.
	Gear loss	0									
	Navigation/ steaming	1	4	3	Water quality	Southern Pelagic Province-coastal (P7)	1.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Emissions, noise and vibration, during the passage of the vessel and gear through water column will occur during the normal course of steaming throughout the fishing operations. Intensity> minor - effect confined to relative vicinity of vessels. Consequence> negligible - remote likelihood of detection at any spatial or temporal scale. Confidence> high – logical.
	Activity/ presence on water	1	4	3	Habitat structure and function	Southern Pelagic Province-coastal (P7)	5.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Activity/presence on vessels occurs broadly but effects relatively small surrounds of vessel. Likely to alter habitat structure and function by introduction of visual stimuli and noise either attracting or repelling animals. Intensity> minor - spatial extent restricted to vessel

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											vicinity. Consequence> negligible, impact is temporary and habitat restored immediately vessels and associated activities depart. Confidence > high – logical.
Disturb physical processes	Bait collection	1	3	3	Substrate quality, water quality	Assemblages 16 & 17	3.1	2	2	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Fresh bait collection decreasing due to increased use of frozen bait sourced from the SASF. Bait collection most likely to affect substrate and water qualities of assemblages 16 & 17. Substrate quality may be altered temporarily from impact of seines on the bottom causing capture of fauna, disturbance and resuspension of sediments affecting water quality and potentially smothering filter feeding fauna, and disruption of substrate processes for burrowing bioturbators. Intensity > minor – purse seines rarely hit bottom and in a restricted location. Consequence> minor- possible detectable impact, recovery in habitats in regions of high natural disturbance (currents, tides, storm swell) days to weeks. Confidence>low, the effect of transient and relatively light bottom contact in inner shelf depths,

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											not known and no observer data on bait seining operations.
	Fishing	1	4	3	Habitat structure and function	Assemblages 16 & 17	4.1	2	2	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Habitat structure and function of Assemblages 16 & 17 may be altered from impact of net. Disturbance of pelagic habitats considered negligible. Intensity> minor – purse seines midwater gear and reported to rarely hit bottom. Consequence> minor - possible detectable impact but localised. Confidence> high - gear losses are reported but minor interactions are not, and observer records contain benthos in catch composition.
	Boat launching	0									
	Anchoring/ mooring	0									
	Navigation/ steaming	1	4	3	Habitat structure and function	Southern Pelagic Province-coastal (P7)	5.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Steaming /navigation will disturb physical processes by turbulence and disturbance of water column, but disruption expected to only briefly alter habitat function for macroscopic fauna. Intensity> negligible - remote

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											likelihood of detection at any spatial or temporal scale. Consequence> negligible - not detectable against natural variation. Confidence > high - logical.
External Impacts	Other fisheries; GAB otter trawl, prawn trawl and Danish seine	1	4	5	Habitat structure and function	Assemblages 16,17,18 & 19	5.1	2	2	1	Demersal fisheries e.g. GAB otter trawl, prawn trawl and Danish seine operate nearly daily and are most likely to affect assemblages 16-19. Other fisheries such as SASF, GHAT gillnet, auto longline, demersal longlines, dropline also operate but with relatively little impact on bottom. Intensity> minor - occurs in a few restricted locations, 0-0.04 % trawl footprint with 15-85% closed (Appendix 7.7: Pitcher *et al.* 2018). Consequence> minor - the cumulative effects of fishing may have detectable impact on structure and function, but time to recover days to months. Confidence> high- study of cumulative impact habitat assessment (Pitcher *et al.* 2018).
	Aquaculture	1	4	6	Water quality, substrate quality	Southern Pelagic Province-coastal (P7), assemblages 2, 4, 15 & 16	2.1	3	2	1	Farming of tuna, oysters, abalone, finfish, mussels, microalgae and trout occurs from Denial Bay to Lacepede Bay particularly in Spencer Gulf (https://www.epa.sa.gov.au/soe-2018/coast/pressures-on-the-coast). Most likely risk posed to the water quality of the pelagic province and substrate quality of inshore habitats. Intensity> moderate - occurs broadly along the coast but locally severe (aquaculture leases). Consequence > minor-

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											possible detectable impact on water quality in inshore habitats of Assemblage 4 but unlikely to detect in offshore habitats where purse seine fishery is based. Time to recover from local impact on the scale of days to weeks, at larger spatial scales recovery time of hours to days. Confidence> low- no data on ecosystem connectivity.
	Coastal development	0									
	Other extractive activities	1	4	6	Water quality	Southern Pelagic Province-coastal (P7)	5.1	3	2	1	Until 2003, 13 oil wells were drilled in the GAB with half close to purse seining fishing grounds west of Kangaroo Island. Since 2003, only seismic surveys have been conducted (check ?). At least 37 species considered to be sensitive to underwater noise pollution including seismic noise pollution (Senate Environment and Communications References Committee 2017) and have been forced away from important habitat. Sessile fauna and benthos most likely to be affected by noise associated with seismic activity and extractive or associated shipping activities. Intensity > moderate – activity occurs across broad area but infrequently in immediate area of fishery. Consequence> minor - possible detectable change in behaviour/movement but minimal impact on population dynamics. Time to return to original

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) / ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE(1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											behaviour/movement on the scale of days to weeks. Confidence > low – no data.
	Other non-extractive activities	1	4	6	Habitat structure and function	Southern Pelagic Province-coastal (P7)	5.1	2	2	1	Three major shipping routes pass through the area of the SBT fishery probably daily (Commonwealth of Australia, 2015). The core purse seine area southeast of KI is a military flying and firing zone (Commonwealth of Australia, 2015). Noise & visual stimuli may potentially impact habitat structure and function. Intensity> minor as impact of activity confined to small ship surrounds. Consequence> minor unlikely to detect. Confidence> low-no data.
	Other anthropogenic activities	1	4	5	Habitat structure and function	Southern Pelagic Province-coastal (P7)	5.1	2	1	1	Potentially recreational activities such as whale watching, and charter fishing occur in the area but limited by area and season. Small vessels may impact habitat and structure from alteration of environment with noise or visual stimuli. Intensity > minor, unlikely to be detectable. Consequence> negligible-any change would be undetectable against background variability. Confidence> low -no data.

Community component

Table 2.24 L1.5 - Community component

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
Direct impact with capture	Bait collection	1	3	3	Functional group composition	Southern Pelagic Province – Coastal GAB	2.1	2	2	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Fresh bait collection less common due to increased use of frozen bait sourced from the SASF. Functional group composition might be affected by removal of small pelagic species. Intensity> minor - changes in relative abundance of community constituents of up to 5%. Consequence> minor- possible detectable change in functional group composition but minimal impact. Confidence> low, no data on catch of small pelagic species but reported to be <5 tonnes annually.
	Fishing	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	3	2	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. SBT purse seine fishing most likely to effect species composition of the Southern Coastal GAB pelagic community. Intensity> moderate - occurs broadly across region. Consequence> minor - fishing at

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											current levels has minimal impact on ecosystem function, <5% change in species composition. Confidence> high – TAC for SBT; detailed knowledge of trophic interactions and modelling studies in the GAB.
	Incidental behaviour	0									
Direct impact without capture	Bait collection	1	3	3	Functional group composition	Southern Pelagic Province – Coastal GAB	2.1	2	1	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Fresh bait collection less common due to increased use of frozen bait sourced from the SASF. Escapement mortality from seine most likely to affect functional group composition by removing small pelagics. Intensity> minor – escapement probably minimal and occurs in restricted locations, unlikely to be detectable. Consequence> negligible -unlikely to detect against natural variation. Confidence> low, insufficient knowledge on escapement outcomes.
	Fishing	1	4	3	Species composition	Southern Pelagic Province	1.1	2	2	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Most likely to

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						– Coastal GAB					effect species composition from post-escapement mortality. Intensity> minor-purse-seining highly selective and non-injurious to fish. Consequence> minor - fishing at current levels has minimal impact on ecosystem function, <5% change in species composition. Confidence> high – TAC for SBT and detailed knowledge of trophic interactions and modelling studies in the GAB.
	Incidental behaviour	0									
	Gear loss	0									
	Anchoring/ mooring	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Navigation/ steaming	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Mortality from interaction with fishing vessel/towed cages could potentially affect coastal pelagic sharks , cetaceans, marine mammals. Intensity> minor - sharks known to interact with towed cage but change in species compositions not detectable - none reported in past 5 years. Consequence> negligible- sharks released live, no change in species composition not detectable against natural variation. Confidence> high, interactions must be reported/observer coverage.
	Translocation of species	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	3	1	1	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Translocation of sardine and associated diseases might impact species composition of small pelagic species group. Intensity > moderate – chumming and feeding with frozen sardine occurs often at local scales but moderate at broader spatial scale. Consequence > negligible – change in species composition due to disease mortality has not been detectable against natural variation.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											Confidence > high, no reported disease, bait is collected from SASF.
	On board processing	0									
Addition/ movement of biological material	Discarding catch	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Discarding most likely to affect species composition by increasing relative abundance of large top order predators i.e. sharks by attraction to discarded fish. Intensity> minor - discarding occurs rarely in a few restricted locations. Consequence> negligible - not detectable against natural variation Confidence> high, discarding rate low.
	Stock enhancement	0									
	Provisioning	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	2	1	1	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Provisioning through feeding towed SBT occurs nearly daily and considered to impact on distribution of scavenging species e.g. large top order predators or seabirds by attraction to bait. Intensity>

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											minor–occurs during all fishing operations but within restricted area of seal population but bait/feed largely consumed by SBT and towed cages constantly moving. Consequence > negligible - change in distribution not persistent or detectable against natural variation. Confidence >low - no data.
	Organic waste disposal	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Disposal of food scraps, paper and cardboard occurs offshore and might impact on relative abundance of scavenging species e.g. large top order predators or seabirds by attraction to refuse. Intensity> negligible unlikely to be detectable and effect not persistent. Consequence > negligible - change in distribution not detectable against natural variation. Confidence >high, disposal MARPOL regulated.
Addition of non-	Debris	0									
	Chemical pollution	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
biological material	Exhaust	1	4	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Exhaust emission is mostly gas that enters the atmosphere directly potentially affecting the distribution of seabirds in very close proximity to vessel. Intensity> negligible-detection unlikely and birds able to avoid small impact zone. Consequence> negligible - unlikely to be detectable against natural variation. Confidence> high, logical.
	Gear loss	0									
	Navigation/ steaming	1	4	3	Distribution of the community	Southern Pelagic Province – Coastal GAB	3.1	2	1	1	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Navigation/ steaming introduces noise or echo sounding into the environment possibly affecting marine mammal distribution 37 species considered to be sensitive to underwater noise pollution (Weilgart 2012, Gordon *et al.* 2003, Senate Environment and Communications References Committee 2017) and have been forced away from important habitat. Intensity> minor - effect confined to relative vicinity of vessels.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											Consequence> negligible - noise transient as vessels travel, impact unlikely to be detectable against natural variability. Confidence> low - limited data.
	Activity/ presence on water	1	4	3	Distribution of the community	Southern Pelagic Province – Coastal GAB	3.1	2	1	2	Fishing occurs daily, over an area of 240 x 120 nm, west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Introduction of visual stimuli from activity/presence of vessels might affect distribution of top predator groups particularly birds. Intensity> minor - vessel presence transient and restricted location. Consequence> negligible - change in distribution of community not detectable against natural variation. Confidence> high, logical.
Disturb physical processes	Bait collection	1	3	3	Species composition	Southern Pelagic Province – Coastal GAB	1.1	2	2	1	Fishing occurs daily, west and southeast of Kangaroo Island, over an area of 240 x 120 nm; <5 tonnes per year of fresh bait caught in coastal (State) waters (AFMA pers comm 16/10/2020). The main fishing season for SBT is Dec - April. Impact of seines on the bottom might cause disturbance to benthos and benthic processes and benthic community. Intensity> minor -occurs rarely. Consequences> minor - unlikely to detect any changes to benthic community. Confidence> low - no data.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Fishing	1	4	3	Distribution of the community	Southern Pelagic Province – Coastal GAB	3.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec-April. Disturbance of water column from purse seining might impact the distribution of the community. Intensity> negligible. Consequence> negligible - any consequence of water column disturbance unlikely to be detectable for pelagic communities. Confidence>high, logical consideration.
	Boat launching	0									
	Anchoring/ mooring	0									

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
	Navigation/ steaming	1	4	3	Functional group composition	Southern Pelagic Province – Coastal GAB	2.1	1	1	2	Fishing occurs daily, over an area of 240 x 120 nm west and southeast of Kangaroo Island; main fishing season for SBT is Dec -April. Navigation /steaming might impact bio- and geo-chemical cycles of pelagic waters by disturbing mixed depth layer. Intensity> negligible - navigation/steaming is a large component of the small pelagic species mid water trawling operations, but localised impact within immediate vicinity of the vessel. Consequence> negligible because impact considered likely undetectable against natural levels of mixing and re-mixing. Confidence> high-logical.
External Impacts	Other fisheries: SBT Longline; ETBF; WTBF	1	6	5	Species composition	Southern Pelagic Province – Coastal GAB	1.1	3	3	2	SBT targeted in the SBT Longline fishery sector, and secondary in Eastern Tuna and Billfish Fishery, Western Tuna and Billfish Fishery and recreational fisheries which occur nearly daily throughout the whole range of the SBT fishery. Other fisheries most likely to affect species composition of the large pelagic predator functional group. Intensity> moderate – moderate at broader scale. Consequence> moderate - detectable changes but no major change to overall ecosystem function. Confidence>high-total TAC for SBT set annually to allow rebuilding based on allocation from

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											CCSBT but current stock is at 17% of biomass indicating overfished (ABARES 2020), ecosystem models exist that investigate effects of fishing (Fulton et al, 2019).
	Aquaculture	1	4	6	Functional group composition	Southern Pelagic Province – Coastal GAB	2.1	3	3	2	Farming of tuna, oysters, abalone, finfish, mussels, microalgae and trout occurs from Denial Bay to Lacepede Bay particularly in Spencer Gulf (https://www.epa.sa.gov.au/soe-2018/coast/pressures-on-the-coast). Capture of sardine for aquaculture from Spencer Gulf and western Eyre Peninsula most likely to effect functional group composition, i.e. capture of sardines may alter bait fish functional group. Intensity> moderate – potentially severe at local scales but moderate at broader spatial scale. Consequence > moderate- detectable changes to the ecosystem without a major change in function. Confidence> high- sardine fishery closely monitored and assessed.
	Coastal development	0									
	Other extractive activities	1	4	6	Distribution of the community	Southern Pelagic Province	3.1	3	2	1	Until 2003, 13 oil wells were drilled in the GAB with half close to purse seine fishing grounds west of Kangaroo Island. Since 2003, only seismic surveys have been conducted. Cetaceans such as

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
						– Coastal GAB					blue whales are among at least 37 species considered to be sensitive to underwater noise pollution including seismic noise pollution (Senate Environment and Communications References Committee 2017) and have been forced away from important habitat. Distribution of marine mammal community in the coastal pelagic zone most likely to be affected by noise associated with seismic activity and extractive or associated shipping activities. Intensity > moderate – activity occurs across broad area but infrequently in immediate area of fishery. Consequence> moderate - possible detectable change in geographic range up to 5% but minimal impact. Confidence > low – no data.
	Other non-extractive activities	1	4	6	Distribution of the community	Southern Pelagic Province – Coastal GAB	3.1	2	2	1	Three major shipping routes pass through the area of the SBT fishery probably daily (Commonwealth of Australia, 2015). The core purse seine area southeast of KI is a military flying and firing zone (Commonwealth of Australia, 2015). Noise & visual stimuli from coastal shipping may disrupt large pelagic predator and bird feeding or movement patterns. Intensity> minor as impact of activity confined to small ship surrounds. Consequence> minor

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	PRESENCE (1) ABSENCE (0)	SPATIAL SCALE OF HAZARD (1-6)	TEMPORAL SCALE OF HAZARD (1-6)	SUB-COMPONENT	UNIT OF ANALYSIS	OPERATIONAL OBJECTIVE (FROM S2.1)	INTENSITY SCORE (1-6)	CONSEQUENCE SCORE (1-6)	CONFIDENCE SCORE (1-2)	RATIONALE
											unlikely to detect or only in restricted locations. Confidence> low-no data.
	Other anthropogenic activities	1	4	5	Distribution of the community	Southern Pelagic Province – Coastal GAB	3.1	2	1	1	Potentially recreational activities such as whale watching and charter fishing occur in the area but limited by area and season. Small vessels may impact distribution of large pelagic predator and birds by altering the environment with noise or visual stimuli. Intensity > minor, unlikely to be detectable. Consequence> negligible-any change would be undetectable against background variability. Confidence> low -no data.

Summary of SICA results

Table 2.25 Level 1 (SICA) Document L1.6. Summary table of consequence scores for all activity/component combinations. Those that scored ≥3 are highlighted blue and bolded if high confidence. * assessment not required. Note: external hazards are not considered at Level 2.

DIRECT IMPACT OF FISHING	FISHING ACTIVITY	KEY COMM-ERCIAL	BYCATCH BYPRODUCT	PROTECTED	HABITATS	COMMUNITIES
Capture	Bait collection	2	2	2	2	2
	Fishing	0	2	1	2	2
	Incidental behaviour	0	0	0	0	0
Direct impact without capture	Bait collection	1	1	2	1	1
	Fishing	2	1	2	2	2
	Incidental behaviour	0	0	0	0	0
	Gear loss	0	0	0	0	0
	Anchoring/ mooring	0	0	0	0	0
	Navigation/ steaming	1	1	2	1	1
Addition/ movement of biological material	Translocation of species	1	1	1	1	1
	On board processing	0	0	0	0	0
	Discarding catch	1	2	2	1	1
	Stock enhancement	0	0	0	0	0
	Provisioning	2	2	2	1	1
	Organic waste disposal	1	1	1	1	1
Addition of non-biological material	Debris	0	0	0	0	0
	Chemical pollution	0	0	0	0	0
	Exhaust	1	1	1	1	1
	Gear loss	0	0	0	0	0
	Navigation/ steaming	1	1	2	1	1
	Activity/ presence on water	1	1	2	1	1
Disturb physical processes	Bait collection	1	1	1	2	2
	Fishing	1	1	1	2	1
	Boat launching	0	0	0	0	0
	Anchoring/ mooring	0	0	0	0	0
	Navigation/steaming	1	1	1	1	1
External	Other fisheries	3	2	3	2	3
	Aquaculture	2	2	4	2	3
	Coastal development	0	0	0	0	0
	Other extractive activities	2	2	2	2	2
	Other non-extractive activities	2	2	2	2	2
	Other anthropogenic activities	1	1	1	1	1

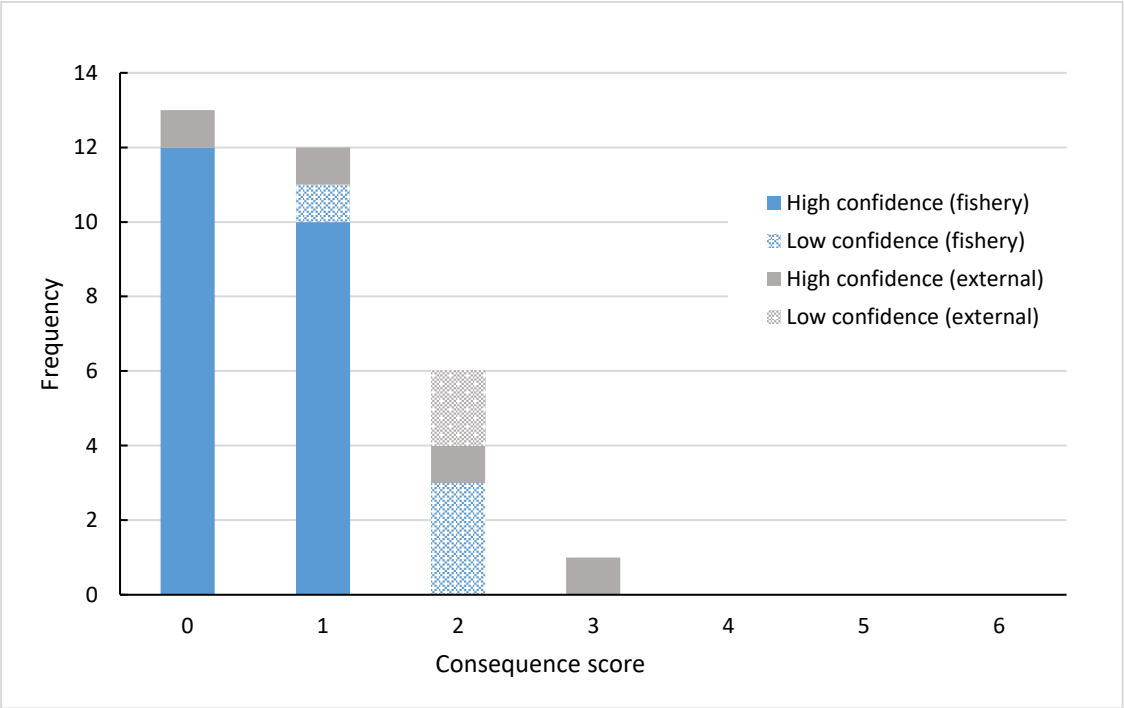


Figure 2.3 Key commercial species: Frequency of consequence score differentiated between high and low confidence.

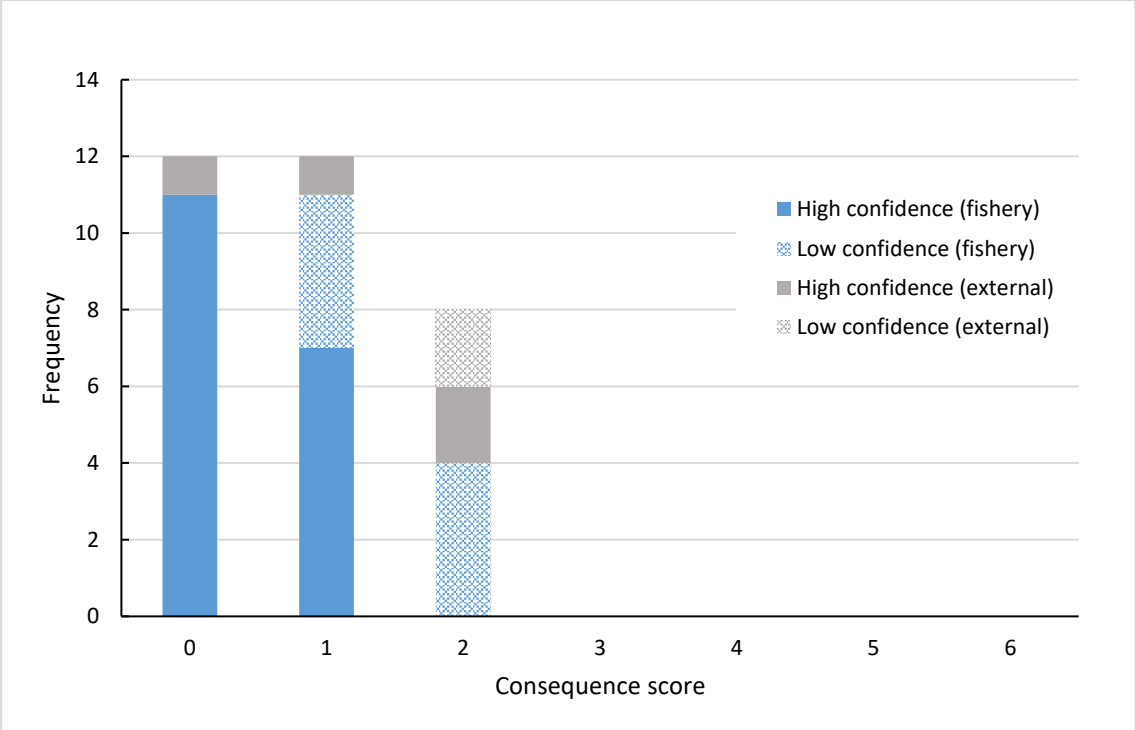


Figure 2.4 Byproduct and bycatch species: Frequency of consequence score differentiated between high and low confidence

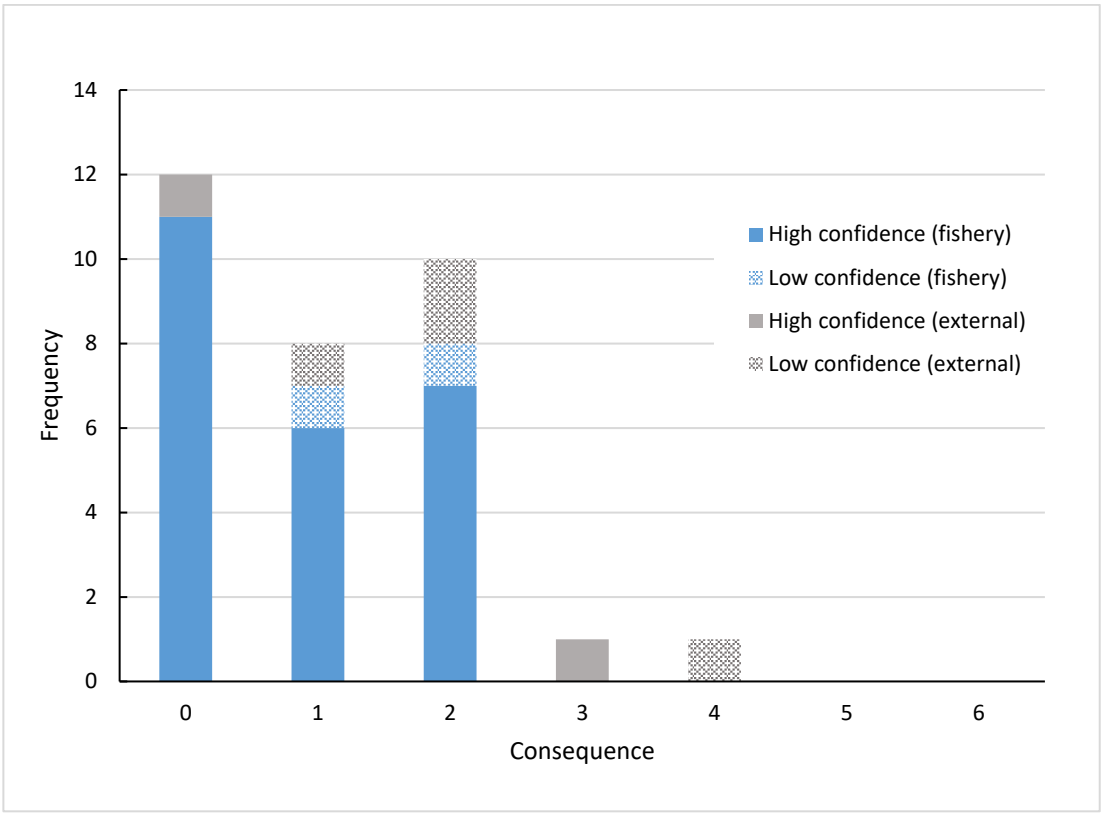


Figure 2.5 Protected species: Frequency of consequence score differentiated between high and low confidence

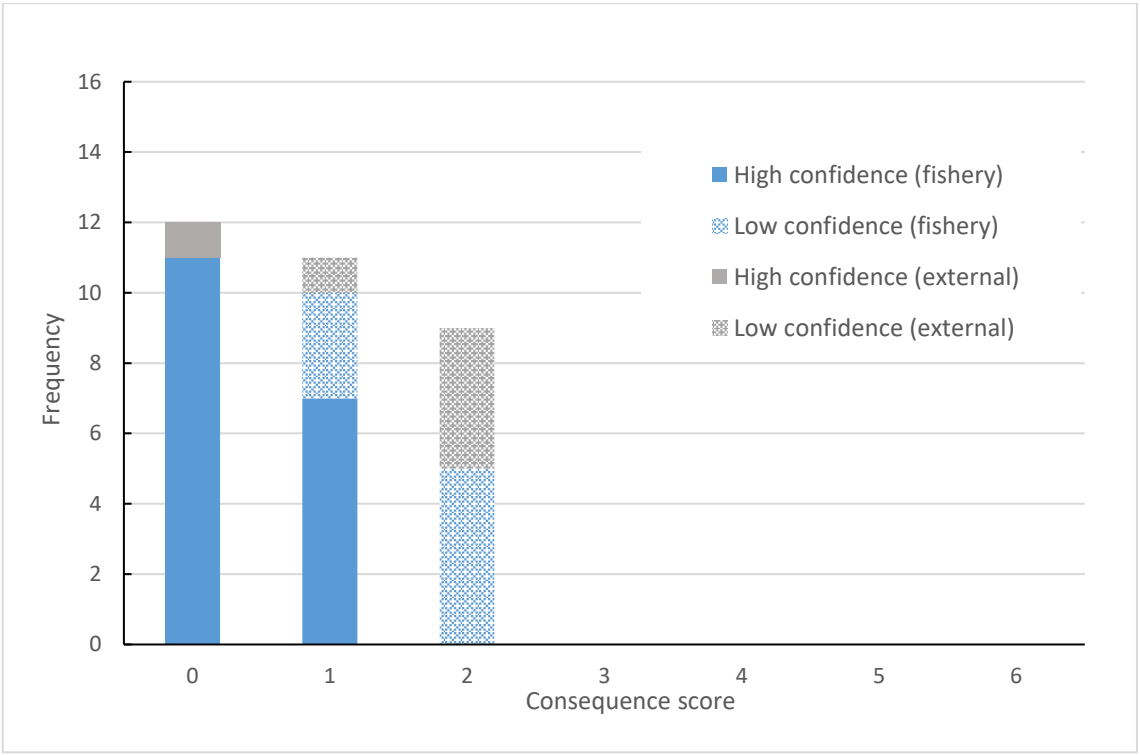


Figure 2.6 Habitats: Frequency of consequence score differentiated between high and low confidence

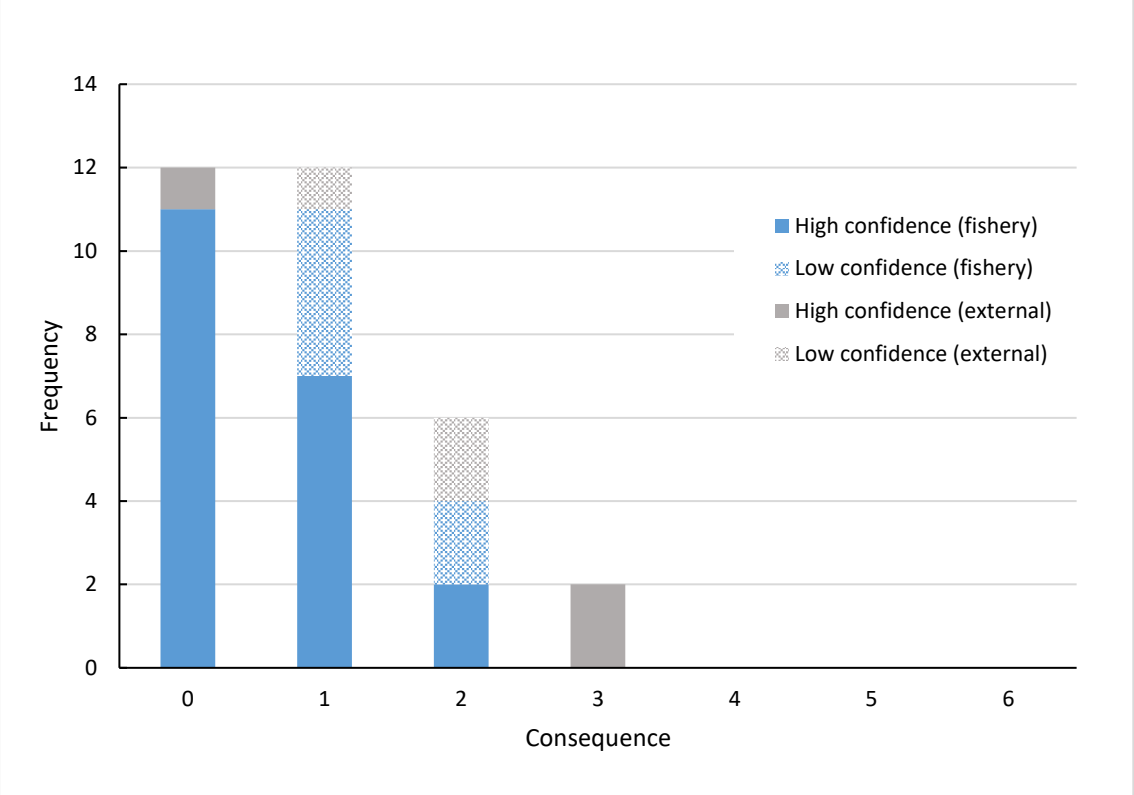


Figure 2.7 Communities: Frequency of consequence score differentiated between high and low confidence

2.3.12 Evaluation/discussion of Level 1

This section provides a brief discussion of the results of the Level 1 analysis. Full details and rationale for the scores are provided in the SICA tables earlier in this section.

Of the 32 possible activities (hazards), 20 were identified as occurring in the SBT purse seine sub-fishery - 15 internal and 5 external. A total of 99 scenarios were scored – 19 activities for key commercial species (see Table 2.25; 14 internal; 5 external) and 20 (15 internal; 5 external) for each of the other four components. None of the internal scenarios, and five external scenarios, were identified as having an impact of moderate or above (see **Level 1 (SICA) Document L1.6**).

The external activities that impacted components relevant to the SBT purse seine sub-fishery were other fisheries on key commercial and protected species, and communities, and aquaculture on protected species and communities.

There is only one key commercial species, Southern Bluefin Tuna (SBT) *Thunnus maccoyii*, permitted to be captured in this fishery unless statutory rights for other captured species are held. The CCSBT assessment of SBT determines a global TAC that allows the rebuilding of the stock. SBT is currently estimated to be at 20% of unfished levels (CCSBT 2020). The higher-level of SBT excluded it from assessment of direct capture by fishing but other activities were still assessed. Only external fisheries were found to be of moderate or high risk to SBT. It was noted by Patterson *et al.* (2020a) that accounting for all mortality sources i.e. from recreational and indigenous catch, improving the confidence in estimates of purse seine catches, and supporting stock recovery were necessary to maintain Australia's export trade approval, an important consideration for SBT fishery management. Recreational fishing now

receives 5% of the CCSBT allocation. SBT is now classified as not subject to overfishing, although the stock biomass is still overfished.

Live bait is caught with smaller nets for the purposes of attracting tuna. Unlimited amounts of bait species are permitted but since using frozen sardine sourced from the South Australian Sardine Fishery (SASF) is now the preferred practice, the practice of catching live bait is decreasing. Currently, catches of bait are not recorded but are reported to be less 5 tonnes per year (M. Daniel 16/10/20 pers. comm.). Several of the bait species i.e. Redbait *Emmelichthys nitidus*, Jack Mackerel *Trachurus declivis*, Australian Sardine *Sardinops sagax* and Blue Mackerel *Scomber australasicus* are assessed within the Small Pelagic Fishery or the SASF therefore we did not consider impact of direct capture on the populations themselves, only on other species. Overall, all internal activities were assessed as low risk and only the combined other fisheries, an external activity, was assessed as a moderate risk.

The targeted nature of the Purse Seine fishery, the depth at which it is conducted, and the fact that live fish are transferred to cages to be towed slowly inshore to grow-out facilities, minimizes the risk of capture of non-target species, and for those that might be captured, all efforts are made to release them. No species were recorded as being landed or discarded in the fisher's logbooks, but the observers recorded some discarding including large quantities of jellyfish, and some sponges. Other species recorded by the observers since 2015 were usually single occurrences or less than 20 kg. The only species discarded of any commercial importance was Skipjack Tuna *Katsuwonus pelamis*. The Indian Ocean Tuna Commission's assessment of Skipjack Tuna estimates the stock to be above the target reference point of 40% of unfished spawning biomass (IOTC 2017) and there has been no effort in the Australian Skipjack fishery since 2008/9 (Patterson & Mobsby 2020). The existence of a current stock assessment meant we did not assess Skipjack for direct capture despite uncertainty about the inclusion of discard mortality from a variety of fisheries in those assessments. Furthermore, we found no activities that presented more than a minor risk to Skipjack Tuna. Instead, we chose Bronze Whalers *Carcharhinus brachyurus* as the most vulnerable species subject to capture by fishing because it is often caught and released and has no estimates of population. However, we did assess other activities' impacts on Skipjack when appropriate. There were no activities either internal or external that were assessed as moderate or higher risk.

Historically, interactions with protected species are rare and during this assessment period none were caught or injured. However, a few species are influenced by the operations, particularly chumming. According to observer reports, short-tailed and flesh-footed shearwaters *Puffinus tenuirostris* and *Puffinus carneipes,* are commonly seen feeding on the bait often to the extent that the tuna cannot access the baits. Flesh-footed Shearwaters were the most abundant bird observed during the current assessment period. The previous assessment period reported two white sharks *Carcharhinus obscurus* caught and subsequently released but there were no records in the observer reports or logs. The pre-2015 Wildlife logbooks recorded a seal and a Shortfin Mako *Isurus oxyrinchus,* both released. Observers have reported that divers find holes torn by sharks in nets. In view of these interactions we included all these species in the assessment even though there were no physical or fatal interactions. Consequently, no activities were assessed as a moderate or higher risk to protected species. However, the external activities, other fisheries and aquaculture, resulted in moderate to severe consequences respectively.

The Habitats component presented a conundrum. The Purse Seine method is a pelagic method that normally does not impact benthic habitats, but the observer logs recorded the capture of benthos, as much of 400k g sponges, and a few instances of demersal fauna such as sand crabs, stony corals and demersal fishes. While the quantities of these are relatively trivial over the 5-year assessment period even after accounting for the at most ~20% observer coverage, it

raises the question of how often seines touch the bottom, how lightly, and the recovery rate of the vulnerable benthos. However, there is little research about the impact of more frequent "grazes" particularly in vulnerable habitats and this assessment did not identify any vulnerable habitats at risk within the footprint of the fishery. Furthermore, impact from demersal trawling, a relatively destructive method compared to Purse Seine, was among the lowest of all Australian shelf regions (Pitcher at al. 2018), therefore the consequence was considered minor.

Communities were assessed at moderate risk from external fisheries from the additional fishing pressure on SBT and from aquaculture by way of removing small pelagic species to feed the tuna in the grow-out pens. The stock status of SBT is assessed by the CCSBT which manages the allocations to in order to rebuild stocks; AFMA manages the quota allocated to Australia. The community composition of this large predator functional group has been impacted since the 1960s when global catches peaked at 80,000 t (Patterson *et al.* 2020a). Australian catches have remained stable since 1990 and impact of the Purse Seine fishery on the current species composition is unlikely to be causing a major change to the present overall system function. Potentially, the removal of small pelagic species from the SASF to maintain the grow-out of farmed tuna might have also have detectable changes, particularly at a localised scale but without a major change in ecosystem function. Therefore, while the fishery itself did not pose significant consequences to communities, external fisheries and aquaculture did.

2.3.13 Components to be examined at Level 2

As a result of the SICA analysis, there are no components that need to be examined at Level 2 i.e. there are no components with any consequence scores of 3 or above.

Glossary

Assemblage	A subset of the species in the community that can be easily recognized and studied. For example, the set of sharks and rays in a community is the Chondrichthyan assemblage.
Attribute	A general term for a set of properties relating to the productivity or susceptibility of a particular unit of analysis.
Bycatch species	A non-target species captured in a fishery, usually of low value and often discarded (see also Byproduct).
Byproduct species	A non-target species captured in a fishery, but it may have value to the fisher and be retained for sale.
Community	A complete set of interacting species.
Component	A major area of relevance to fisheries with regard to ecological risk assessment (e.g. key commercial species, bycatch and byproduct species, threatened and endangered species, habitats, and communities).
Component model	A conceptual description of the impacts of fishing activities (hazards) on components and sub-components, linked through the processes and resources that determine the level of a component.
Consequence	The effect of an activity on achieving the operational objective for a sub-component.
Core objective	The overall aim of management for a component.
End point	A term used in risk assessment to denote the object of the assessment; equivalent to component or sub-component in ERAEF
Ecosystem	The spatially explicit association of abiotic and biotic elements within which there is a flow of resources, such as nutrients, biomass or energy (Crooks, 2002).
External factor	Factors other than fishing that affect achievement of operational objectives for components and sub-components.
Fishery method	A technique or set of equipment used to harvest fish in a fishery (e.g. long-lining, purse-seining, trawling).
Fishery	A related set of fish harvesting activities regulated by an authority (e.g. South-East Trawl Fishery).
Habitat	The place where fauna or flora complete all or a portion of their life cycle.
Hazard identification	The identification of activities (hazards) that may impact the components of interest.
Indicator	Used to monitor the effect of an activity on a sub-component. An indicator is something that can be measured, such as biomass or abundance.
Key commercial species	A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation.
Likelihood	The chance that a sub-component will be affected by an activity.

Operational objective	A measurable objective for a component or sub-component (typically expressed as “the level of X does not fall outside acceptable bounds”)
Precautionary approach	The approach whereby, if there is uncertainty about the outcome of an action, the benefit of the doubt should be given to the biological entity (such as species, habitat or community).
PSA	Productivity-Susceptibility Analysis. Used at Level 2 in the ERAEF methodology.
Scoping	A general step in an ERA or the first step in the ERAEF involving the identification of the fishery history, management, methods, scope and activities.
SICA	Scale, Impact, Consequence Analysis. Used at Level 1 in the ERAEF methodology.
Sub-component	A more detailed aspect of a component. For example, within the key commercial species component, the sub-components include the population size, geographic range, and the age/size/sex structure.
Sub-fishery	A subdivision of the fishery on the basis of the gear or areal extent of the fishery. Ecological risk is assessed separately for each sub-fishery within a fishery.
Sustainability	Ability to be maintained indefinitely
Target species	A species or group of species whose capture is the goal of a fishery, sub-fishery, or fishing operation. Has been replaced by key commercial in relation to the components.
Trophic position	Location of an individual organism or species within a foodweb.
Unit of analysis	The entities for which attributes are scored in the Level 2 analysis. For example, the units of analysis for the Key commercial Species component are individual “species”, while for Habitats, they are “biotypes”, and for Communities the units are “assemblages”.

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